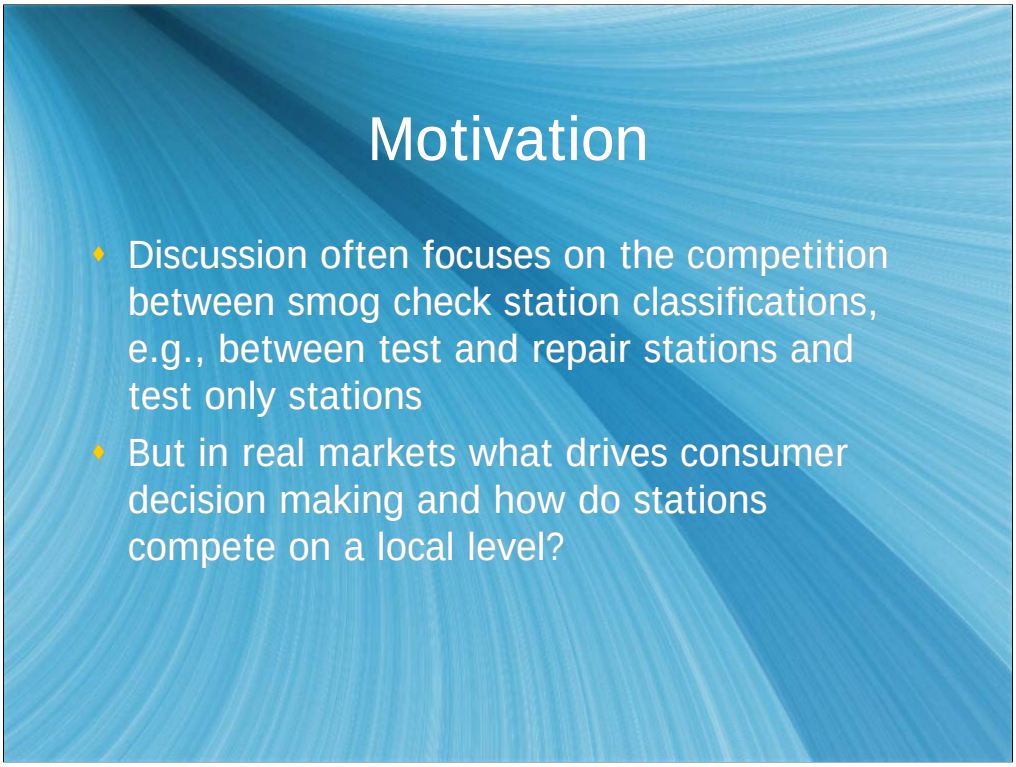
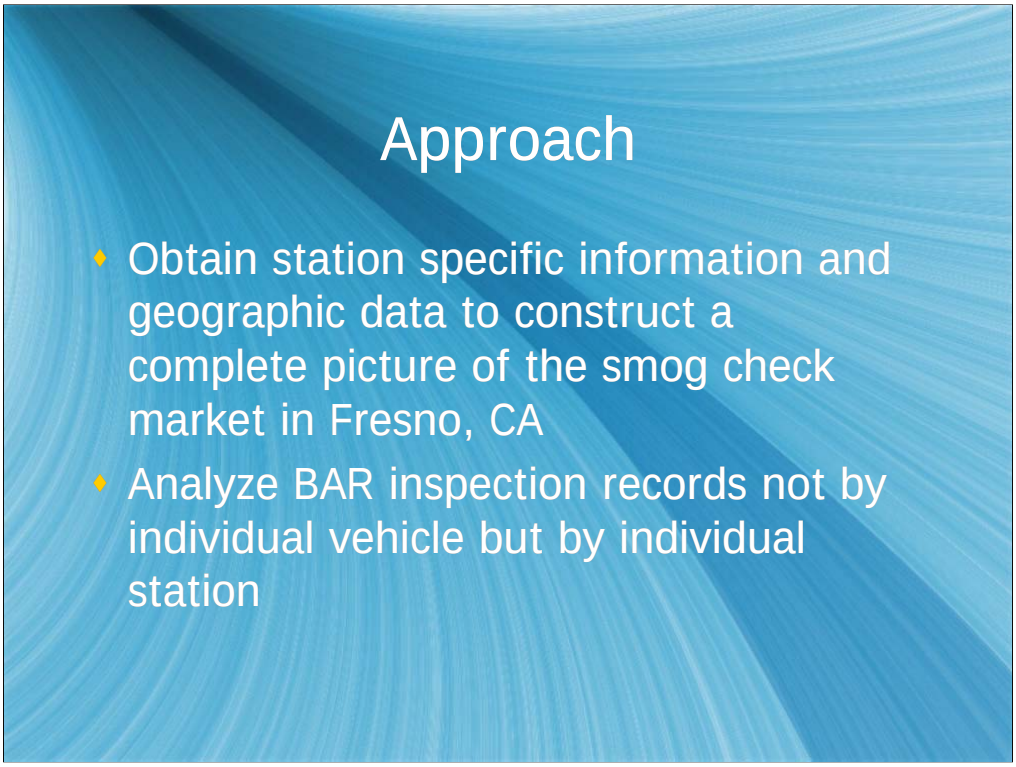
Smog Check Competition in Fresno

This first slide gives us a glimpse into the Fresno smog check world. In this satellite image of one block of North Blackstone Avenue in Fresno there are three smog check stations. The brown building on the upper left is Economy Smog a Test Only station. On the lower right (with the brown roof) is Smog 4 Less another Test Only station while the building on the bottom right is Peak Performance a Test and Repair station. This seems fairly typical in Fresno where there are many stations in extremely close proximity.

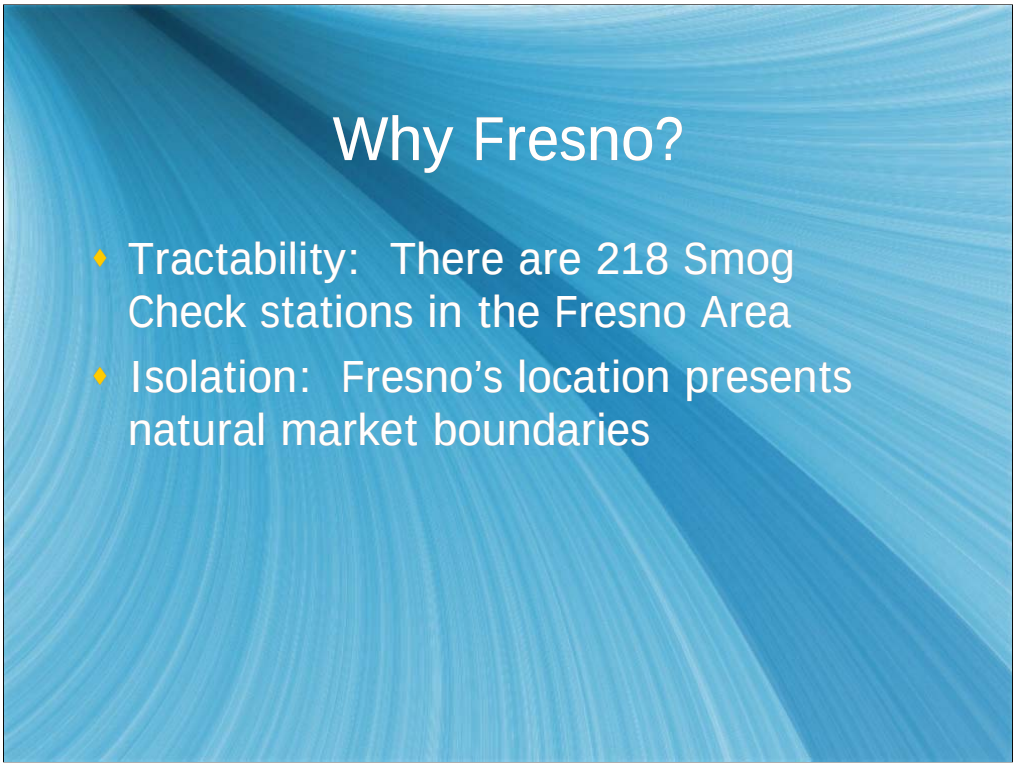


Motivation for this presentation came in large part from previous IMRC meetings that I have attended. While the meetings often focus on the competition between different smog check station classifications i.e., test and repair versus test only, I was really interested in looking at competition between individual stations as well as from the perspective of a consumer. To that end, since I don't own a car, I conducted a 'rigorous' survey of friends and family to find out how real people choose smog check stations. I found out that station location, price and hours of operation were the largest factors in choosing a smog check station.

Today I am going to look at station competition from the consumer's as well as the industry's (aggregate) perspective. Thus, I will look at the local competition between stations, as well as competition between station classification, as they currently exist and with some new modifications.



In order to analyze these types of competition I needed to obtain information from smog check stations pertaining to inspection price, hours and location. I also needed to analyze inspection records, not by vehicle or individual test, by the station conducting the test.



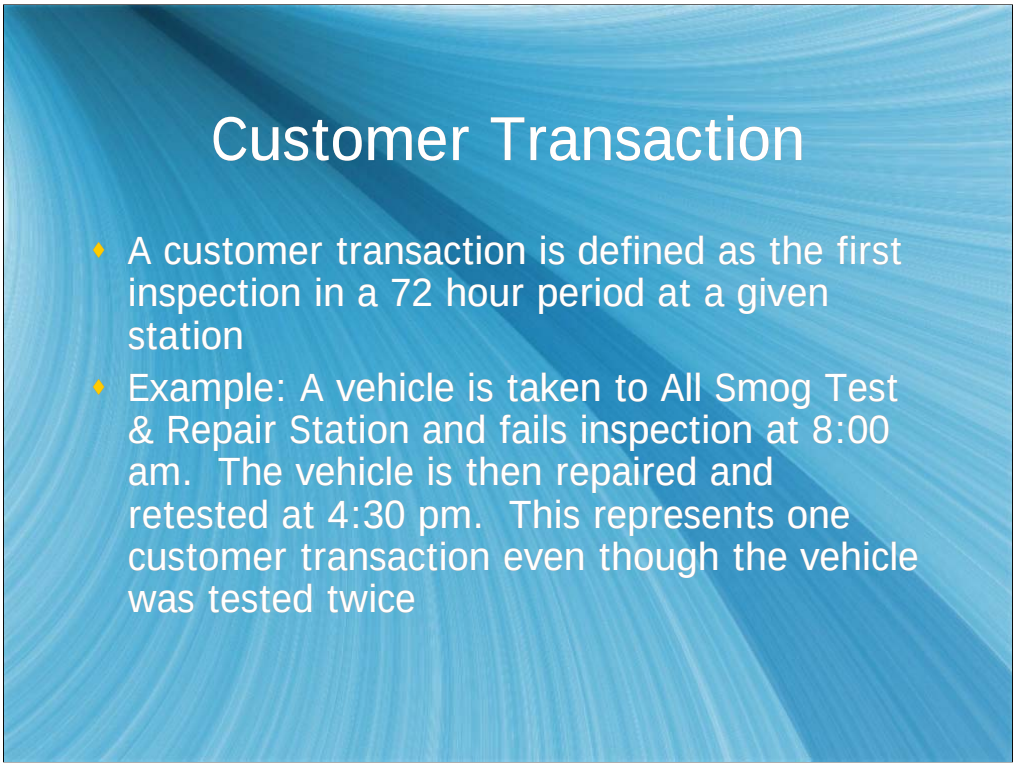
The first step in the analysis was choosing a geographic location to analyze. In order to obtain station level information, I knew I would have to call all smog check stations in the area. Why Fresno? Well, there are 218 smog check stations (according to BAR data obtained from Rocky) under the jurisdiction of the Fresno BAR office. 218 seemed like a reasonable number of telephone calls to make! Also, Fresno's relatively isolated geographic location also presented natural market boundaries, as opposed to LA or San Francisco where the metro area runs into the populated suburbs.

The next step was data. My dissertation advisor turned research assistant, Dr. Williams sorted and organized nearly 6 years of BAR inspection records. Any records in which inspections were conducted at one of the 218 Fresno stations were extracted.

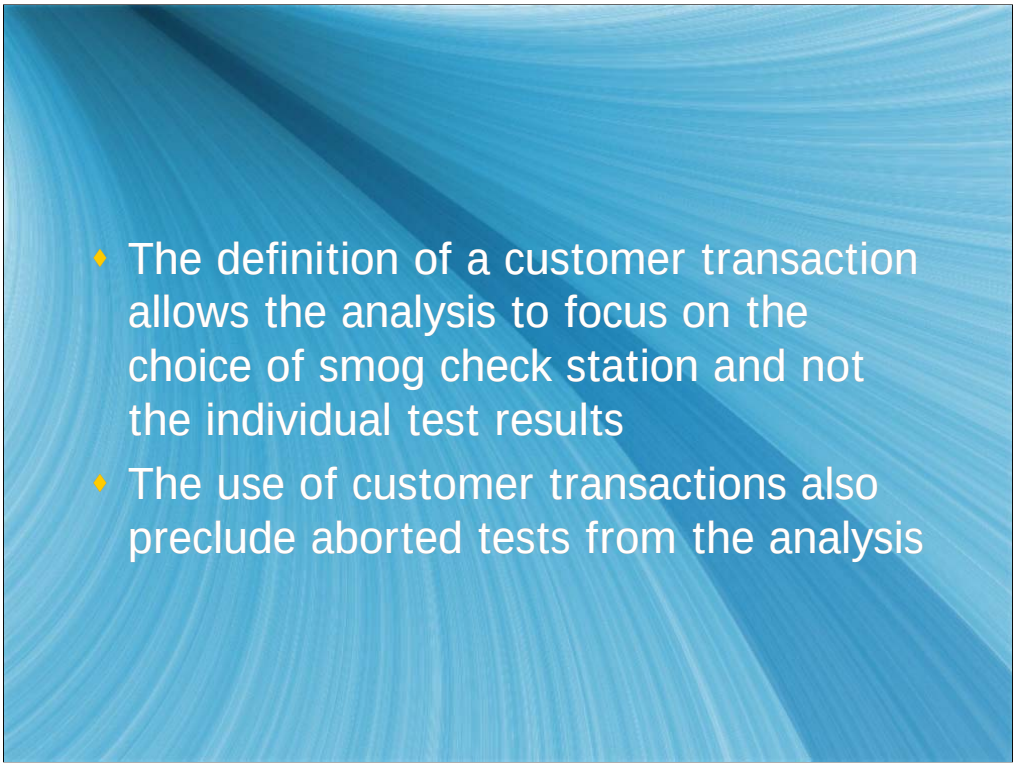
- Each line consists of one customer transaction
- First inspections have zeros in the previous test fields
- Date of test is the number of days from January 1, 2000

Current Test					Previous Test			
Model Year	Station ID	Date of Test	Reason	Result	Station ID	Date of Test	Reason	Result
84	3	1433.458	P	P	250	706.44	P	P
84	100	957.376	C	P	0	0		

Here you see an example of the data. Each line represents one observation, or what I will call a customer transaction. Each line consists of information describing the current as well as the most recent customer transaction. All vehicle characteristics were suppressed except for the model year of the vehicle. One vehicle may have may observations, or customer transactions. The station ID variable does not correspond to a BAR issued ID but is a randomly assigned number between 1 and 218, the number of all stations in the Fresno area. Station ID 250 represents all California stations outside the Fresno area while station ID 0 indicates that the current test is the first test of the vehicle. A record may have either a 250 or a 0 as a station ID but not both as this is an indication that no tests for this specific vehicle occurred in the Fresno area.

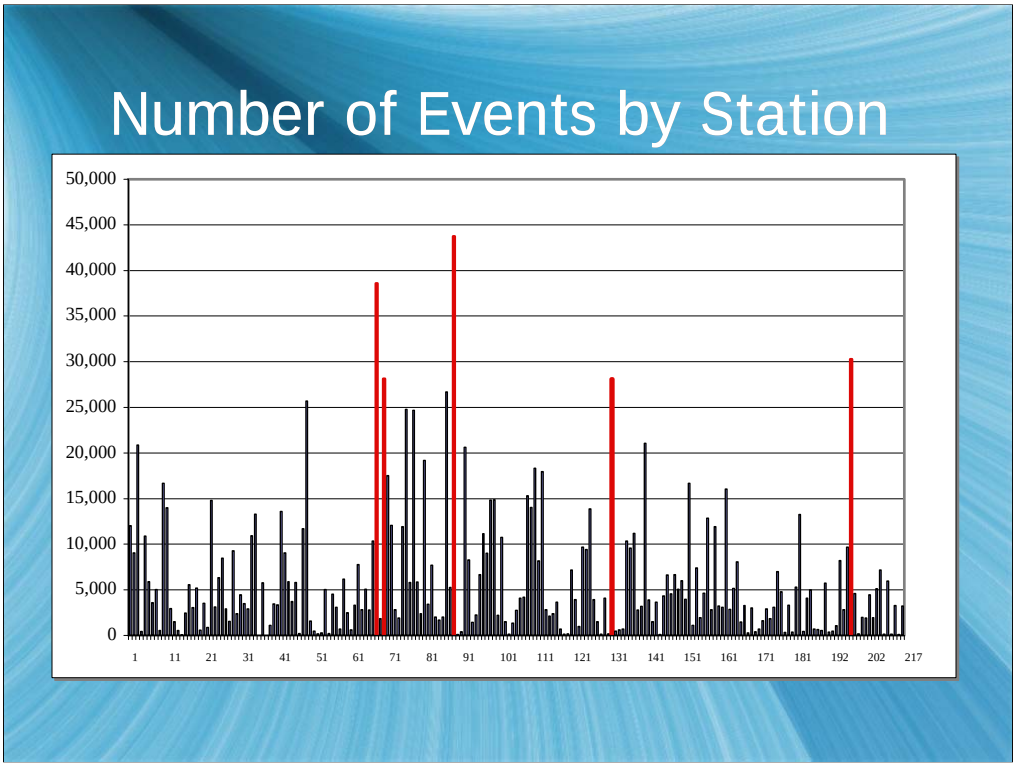


In order to focus on the consumer's choice of a smog check station and to focus on the performance of individual stations, the unit of observation in this analysis (as previously mentioned) is a customer transaction. This is defined as the first test administered at a specific station in a 72 period of time.

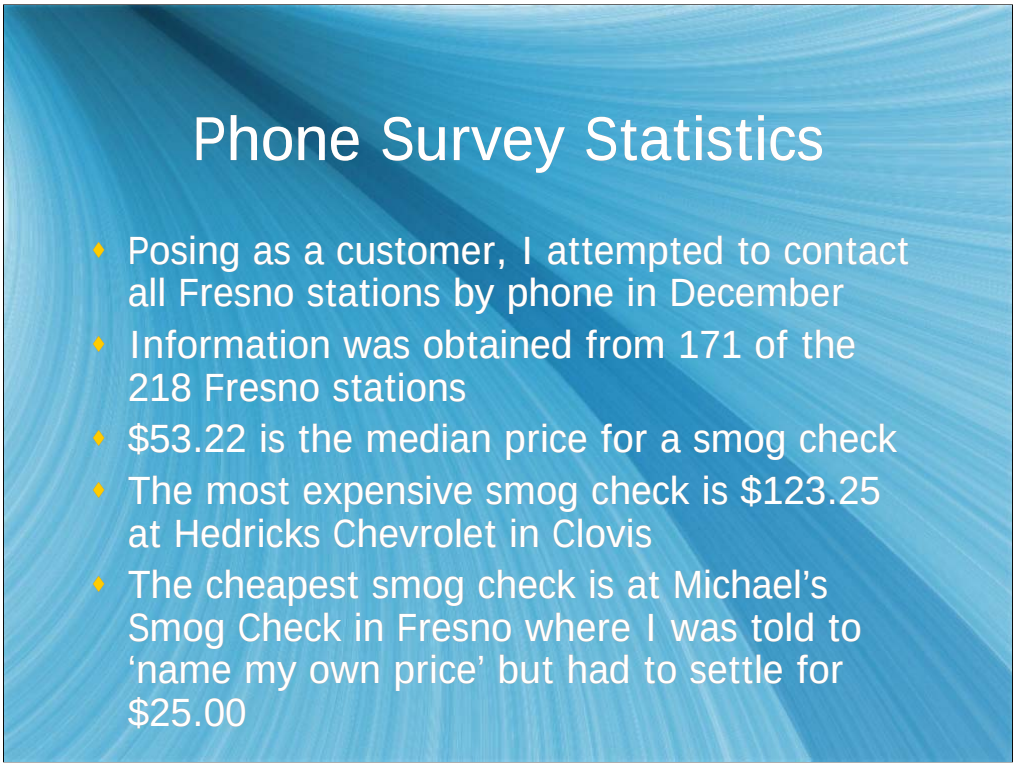


Thus all inspections conducted at the same station within a 72 hour period of time are counted as one transaction and only the first inspection record is recorded. Every time a vehicle changes stations, a customer must make a new decision where to take their vehicle and thus a new customer transaction has begun.

Each balloon represents one of the 218 smog check stations under the guidance of the Fresno BAR office. Test and Repair stations are represented in red while Test Only stations are black and Gold Shield station are green. These stations conducted a total of 1,464,020 customer transactions from January 2000 through September 2005.



The number of transactions conducted by each station varies greatly from a low of 88 to a high of 43,754 over the nearly six years of records. The five stations that conducted the most transactions are highlighted in red. Seeing the variation in this graph made me wonder why some stations do a significantly higher volume than others.

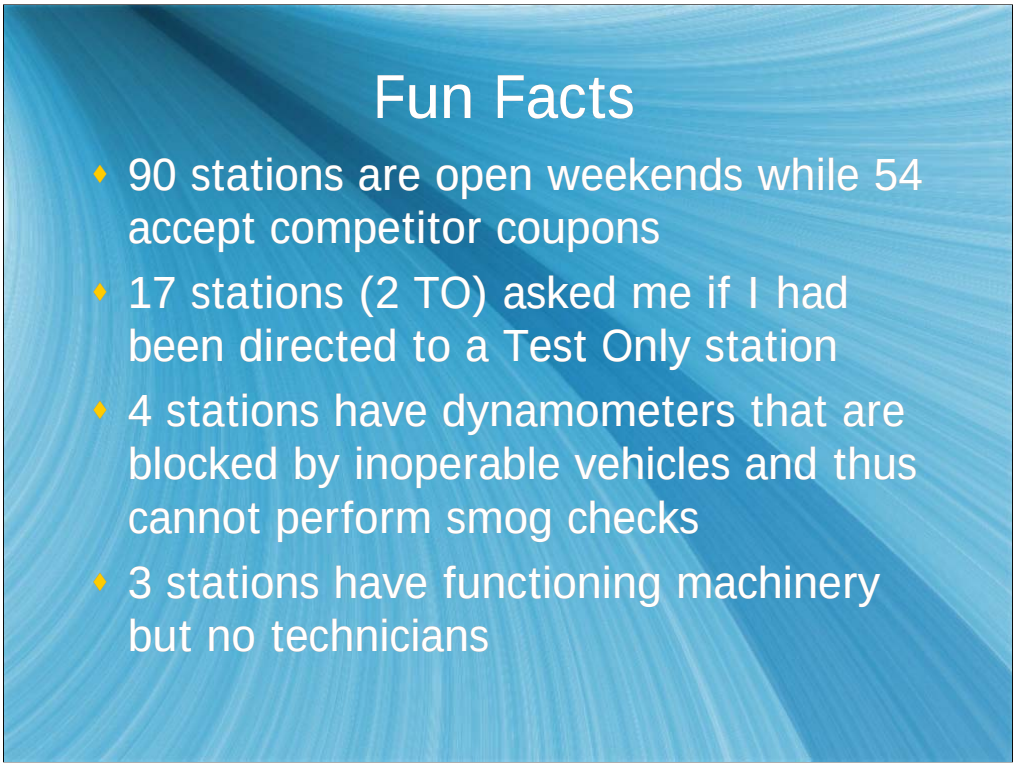


In search of answers I went to the phone and called all 218 stations in the Fresno area to obtain information about prices, hours and service in an attempt to understand why consumers overwhelmingly choose some stations. I found out some very interesting facts.

Median Price by Category

Median Prices	
Test Only Stations	$49.00
Test and Repair Stations	$55.00
Gold Shield Stations	$55.75
Dealers	$89.95
Chains	$53.00

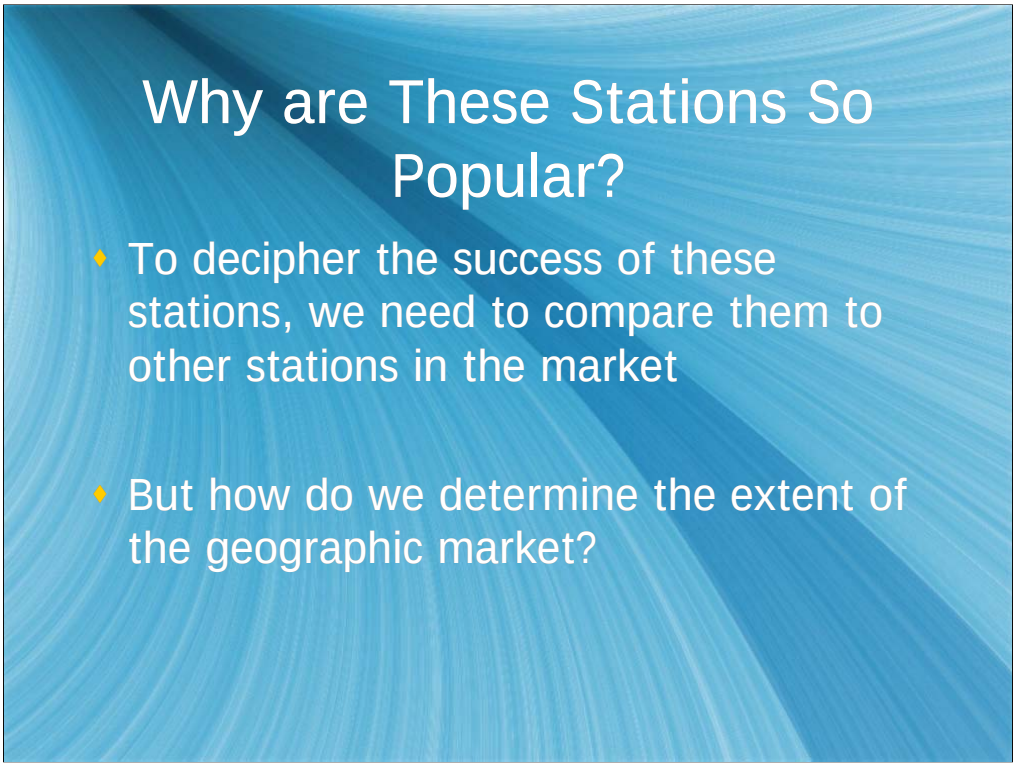
Looking at the inspection cost by station category shows that the median price of an inspection at a Test Only station is well below that of other stations. I also thought it would be interesting to see how the median prices of new car dealers (given the high cost of a test at Hedricks in Clovis) and stations that are part of a chain would compare. It seems unwise ever to go to a dealer for a smog inspection! The category labeled 'chains' consists of franchised stations (such as Pep Boys) as well as smaller outfits consisting of just two locations.



Over half the 171 stations I was able to contact are open at least one weekend day and one fourth accept competitors' coupons. I also learned some unsolicited facts!

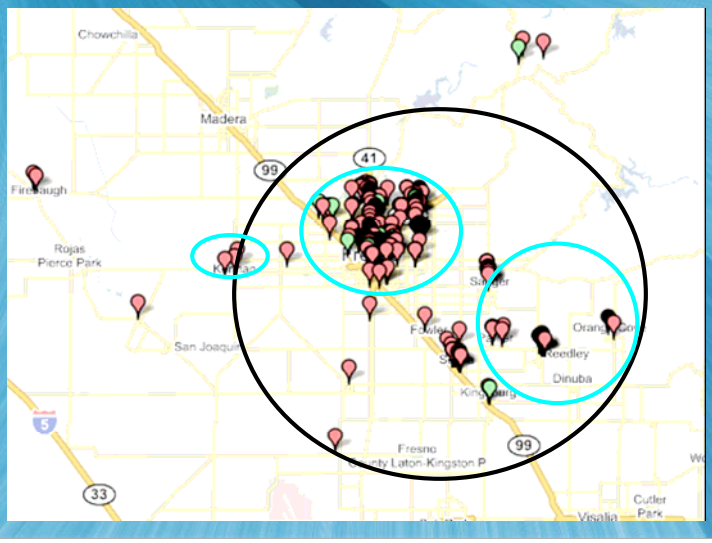
The five stations conducting the most transactions, that were highlighted in red in the previous graph, are now represented by large balloons. Notice that the stations with the highest volumes are either black (Test Only stations) or green (Gold Shield stations).

California Smog Repair, a Gold Shield station, had the highest number of transactions with an average of 144 per week. At the other end of the spectrum, the five stations with the fewest transactions averaged just one every five weeks. The median station in the Fresno area conducted 3,601 transactions or just over 11 a week.

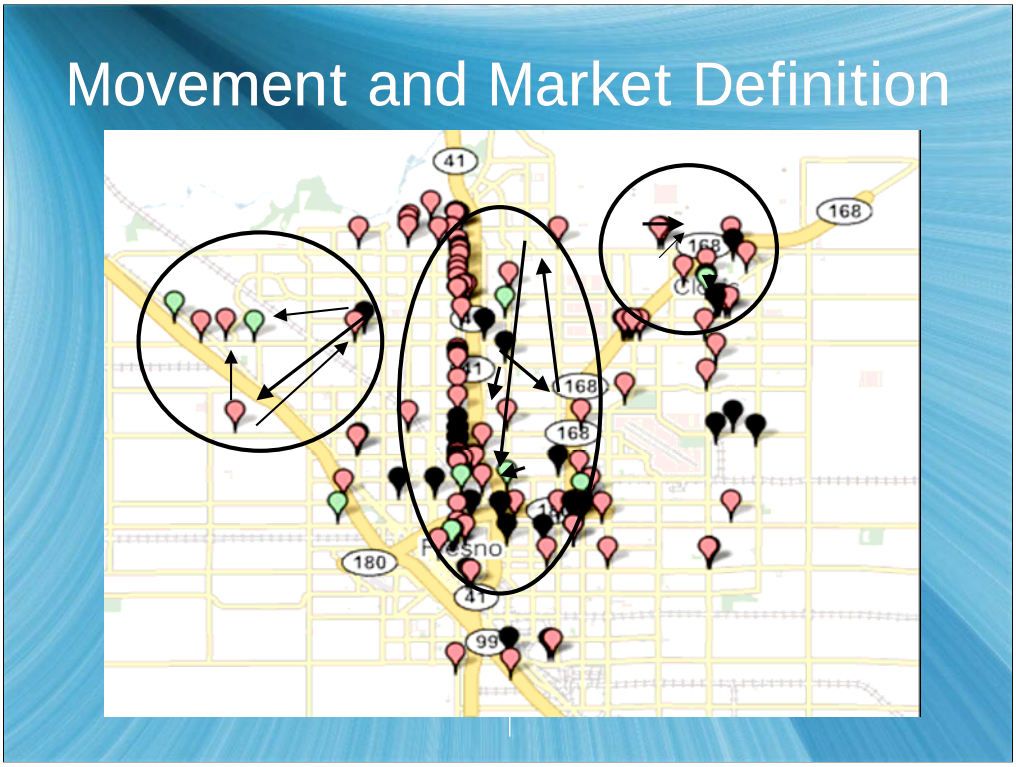


So why do these specific stations have such high volumes? Do they have lower prices than other stations in the area? Are their hours better than other stations? I realized that all my questions were comparing these high volume stations to other stations in the market. But how is the market for smog checks defined, both geographically and in terms of competition?

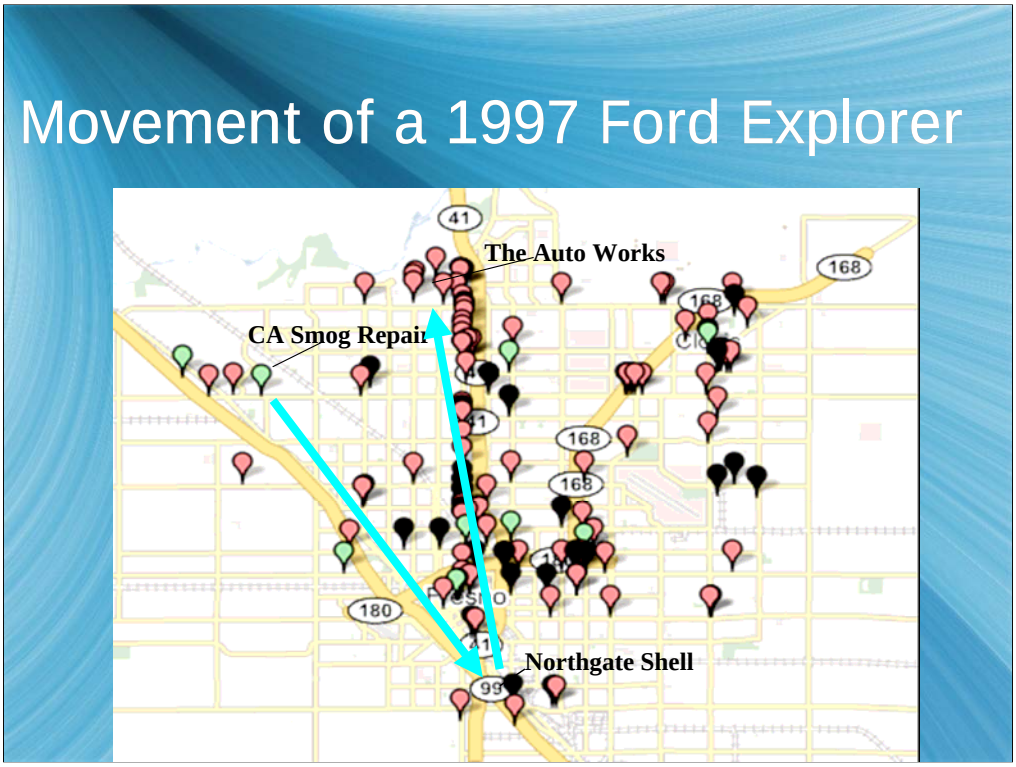
How Are Geographic Markets Defined?



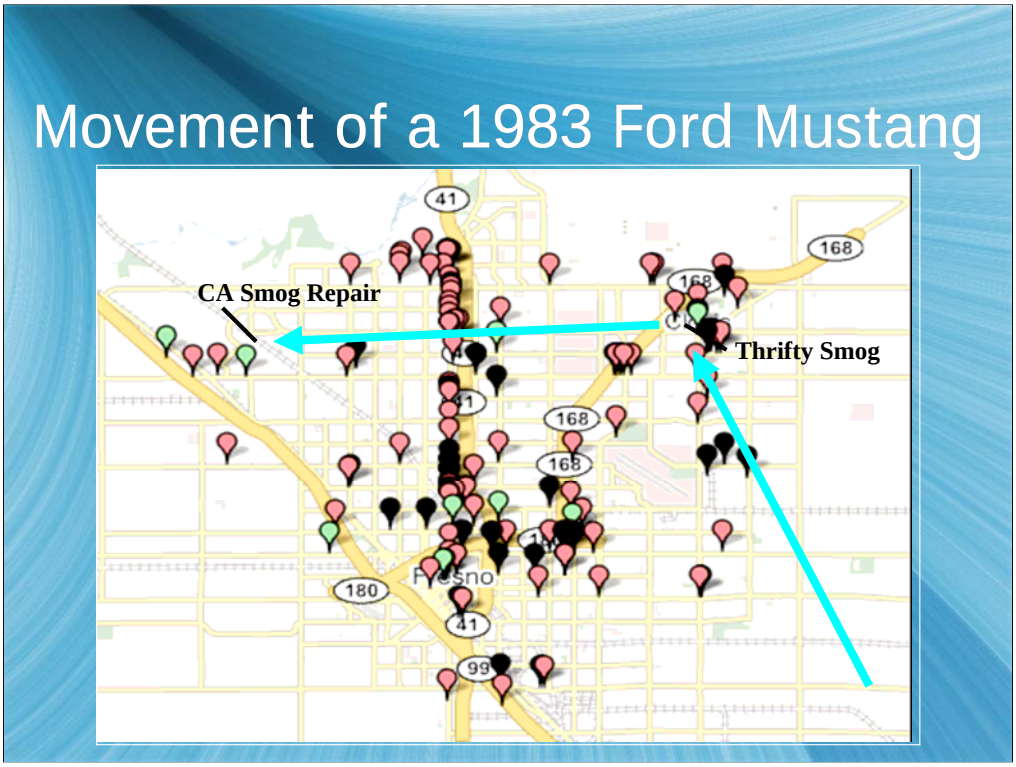
Looking at the map of all Fresno area stations it is not clear how to define the extent of the market. Is there one large geographic market for smog checks (as outlined by the black circle) or are there a few smaller, more distinct markets?



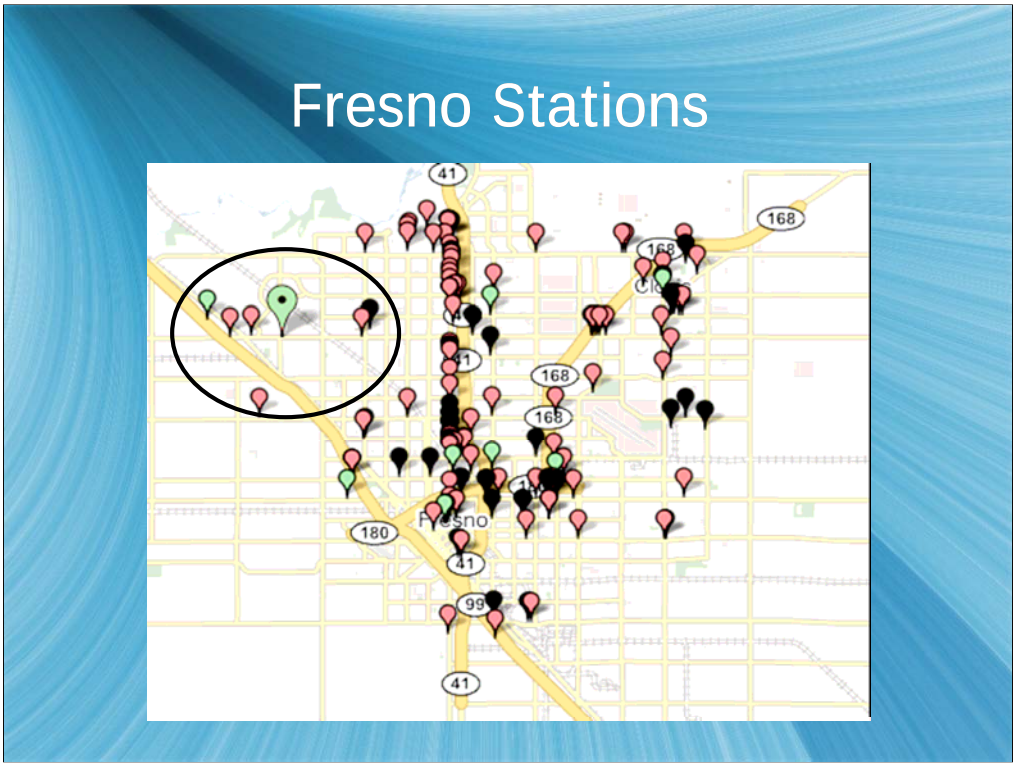
My initial thought was that are many small geographic markets. Looking at a map of downtown Fresno, I divided the city into three regions, Shaw Avenue on the left, Clovis on the right and North Blackstone Avenue in the center. If these are three distinct markets then the main competition between stations should be confined to the geographic area. A signal of this would be vehicle movement between stations in a given area. So if there is a Clovis market for smog checks, then vehicles should predominately move between stations in Clovis and not other Fresno stations.



To test this theory I randomly chose two vehicles that had at least one customer transaction occur at California Smog Repair (in the Shaw Ave. market). I looked at the history of these vehicles and tracked their movement between stations. The first vehicle I tracked was a 1997 Ford Explorer that underwent three biennial transactions at three different Fresno stations. As you can see the Explorer crossed into two different 'market' areas.

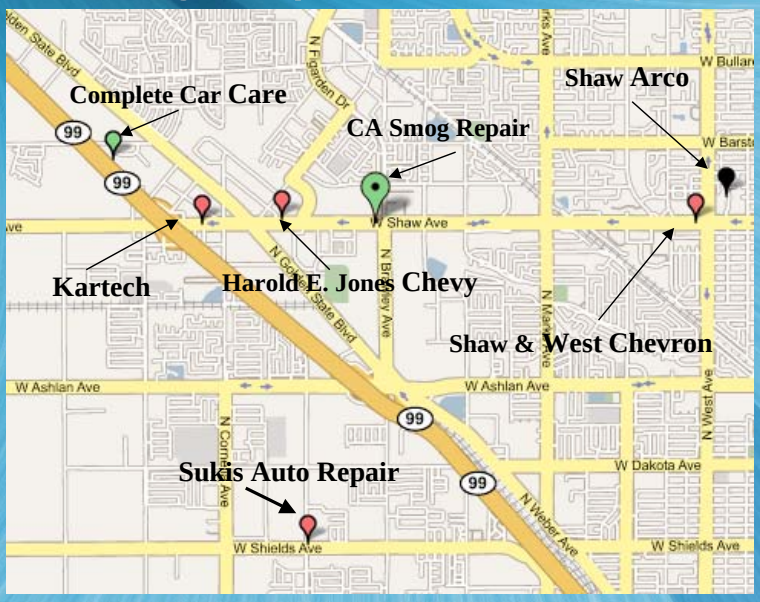


The next vehicle I looked at was a 1983 Ford Mustang. It's first inspection in the time period of the data set was outside of the Fresno area. Its second biennial test was conducted in what I defined as the Clovis market and finally the Mustang traveled to the Shaw Ave. market. Thus, it appears that my idea of distinct markets in the Fresno metropolitan area is not supported by my random vehicle choices. But the concept does deserve a more thorough investigation.



To fully analyze the extent of the geographic market I focus my attention on an isolated group of stations, what I have previously called the Shaw Avenue market. This neighborhood includes California Smog Repair and thus will offer a glimpse into why that station does such a high volume. By analyzing all customer transactions in this area and tracking the movement of vehicles between stations, I can determine if this area is in fact a distinct market for smog checks.

CA Smog Repair and Neighbors

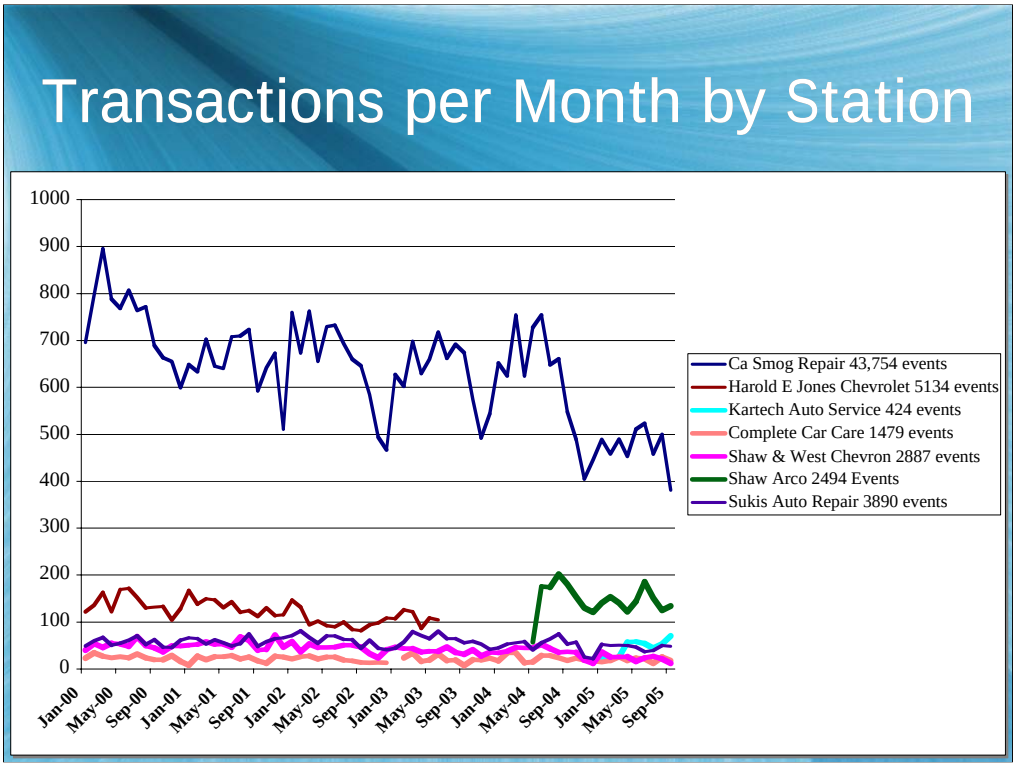


Zooming in to this neighborhood we see that there are two Gold Shield stations, one Test Only station and four Test and Repair stations in a very small geographic area.

Station Details

Station Name	Type	No. Events	Price	Extras
Ca Smog Repair	Gold Shield	43,754	$49.00	Open weekends, accepts coupons
Harold E. Jones Chevro	Test & Repair	5,134		No longer do smogs, dealer
Kartech Auto Service	Test & Repair	424		No answer after 7 phone calls
Complete Car Care	Gold Shield	1,479	$68.00	
Shaw & West Chevron	Test & Repair	2,687	$67.25	
Shaw Arco	Test Only	2,494	$45.20	Open weekends, accepts coupons
Sukis Auto Repair	Test & Repair	3,890	$58.20	Open weekends, accepts coupons

Looking at the station specific information, California Smog Repair's transaction volume by far dominates all other stations in the area. It's price is also one of the lowest and it is open on the weekends. Note in this chart that the names of Gold Shield stations are in green while Test Only stations are represented in blue.

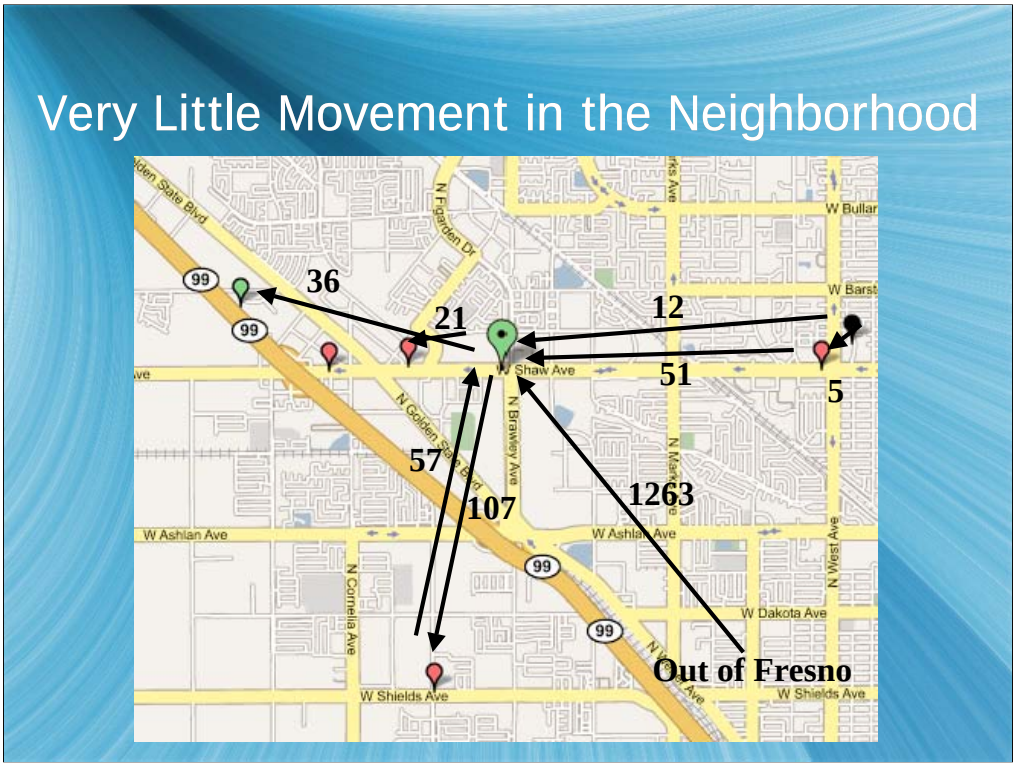


The customer transactions per month show that California Smog Repair has been the dominant station in this neighborhood since the beginning of the dataset, in January 2000. But you will also notice that there is a definite downward trend in transactions per month. This may be due to the entry of two new stations, Kartech Auto Service and Shaw Arco as well as competition from other stations.

Movement Between Stations

	Previous Station						
Current Station	**CA Smog**	Harold E. Jones	Kartech	**Complete Car**	Shaw & West	**Shaw Arco**	Sukis
CA Smog	**9436**	57	3	23	51	**12**	57
Harold E. Jones	21	**710**	0	1	6	0	1
Kartech	12	0	**8**	0	0	1	2
Complete Car	36	1	0	**323**	0	2	0
Shaw & West	42	14	0	1	**428**	**5**	1
Shaw Arco	66	2	1	0	23	**136**	4
Sukis	107	4	0	14	2	0	**708**

This matrix diagrams the movement of vehicles between stations. The rows show the stations conducting the current transaction while the columns represent the stations at which the previous transaction occurred. Thus the box of 107 on the lower left represents all vehicles that moved from California Smog Repair to Sukis. Repeat business is shown in bold along the diagonal. Looking at the off diagonals, there is little movement between stations in this region. I was especially surprised that there is little movement between Shaw Arco, a Test Only station, and Shaw and West 76, a Test and Repair station. These stations are across the street from one another, yet more vehicles moved from Shaw Arco to California Smog Repair than to Shaw and West. This could be a result of the $24 retest fee at Shaw Arco which may be driving customers to a Gold Shield station for repairs, instead of the much closer Test and Repair station.

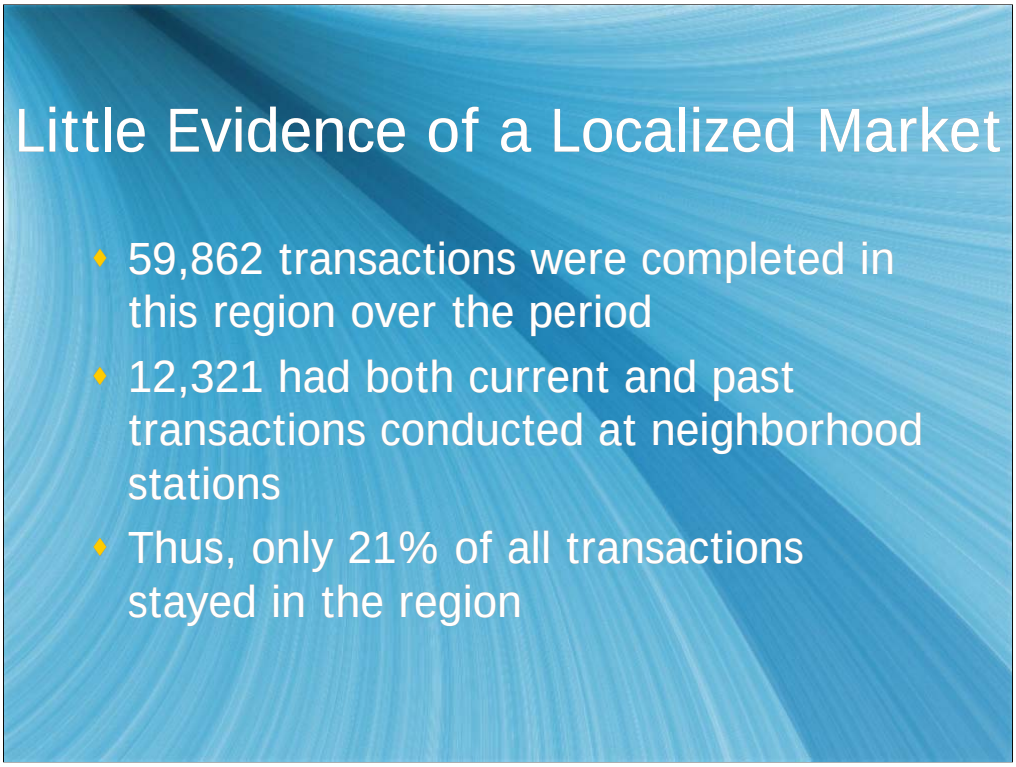


Looking at the movement on the map, we can see that there is very little movement between stations in this region. The little movement is even more apparent given that 1263 vehicles move from stations outside of Fresno to California Smog Repair, a figure that dwarfs all others on the map.

Movement Given 60 Days Between Transactions

	Previous Station						
Current Station	**CA Smog**	Harold E. Jones	Kartech	**Complete Car**	Shaw & West	**Shaw Arco**	Sukis
CA Smog	**7952**	51	2	20	50	8	47
Harold E. Jones	20	**496**	0	1	6	0	1
Kartech	11	0	**3**	0	0	1	2
Complete Car	29	1	0	**228**	0	2	0
Shaw & West	35	14	0	1	**400**	1	1
Shaw Arco	63	2	0	0	23	**42**	4
Sukis	90	4	0	13	2	0	**572**

Looking at movement between stations given 60 days between transactions, we can see again by the low off diagonal numbers that there is little movement between stations. Most of the repeat business stayed the same with the exception of Shaw Arco where the number of vehicles with two consecutive transactions at the station dropped by 2/3.



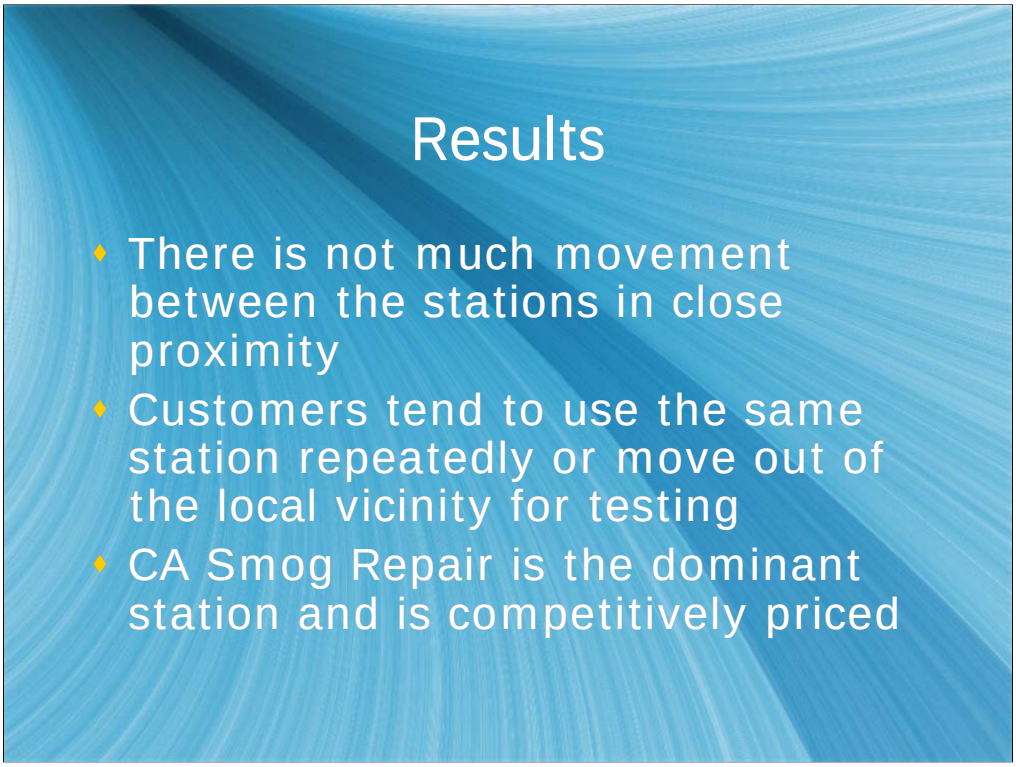
The little movement between stations shows that competition between stations is not confined to the Shaw Avenue region. So the question is then, from where do these Shaw Avenue stations draw vehicles and what stations are their main competitors?

From Where Do Vehicles Come?

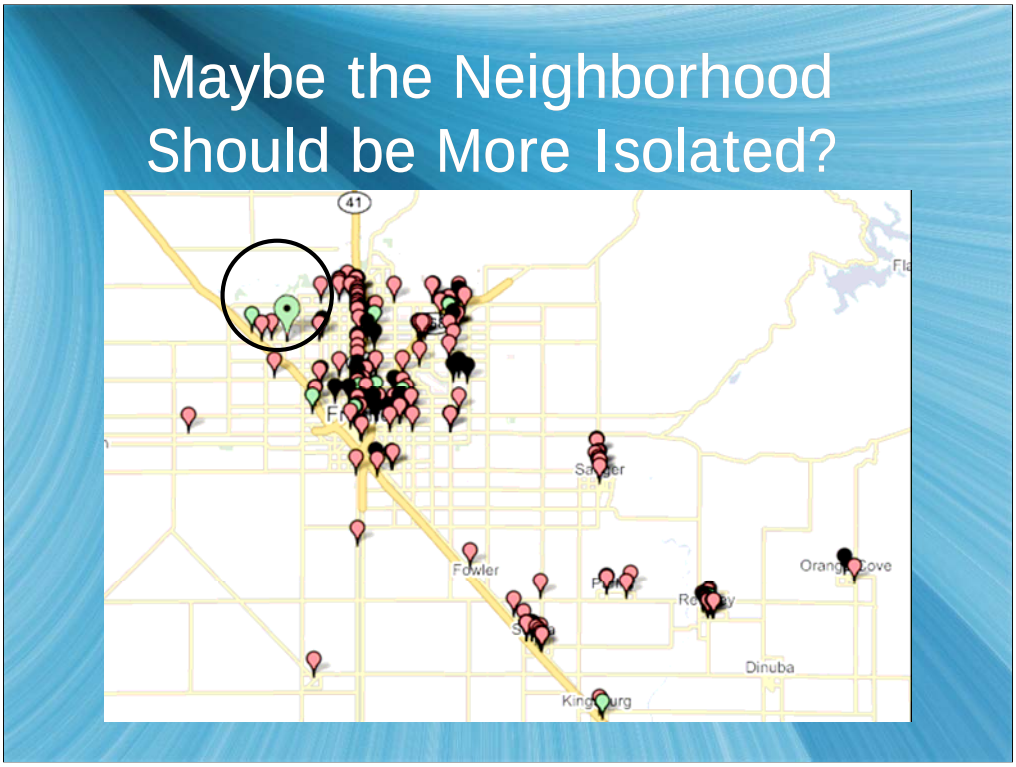
	Previous Station					
Current Station	Same Station	Local Stations	Fresno Stations	Out of Fresno	Initial Test	First Appearance
CA Smog	9,436	203	6,793	1,263	3,569	22,547
Harold E. Jones	710	29	454	86	326	3,531
Kartech	8	15	120	13	108	162
Complete Car	323	39	289	38	91	699
Shaw & West	428	63	433	52	267	1,645
Shaw Arco	136	96	1,184	145	256	681
Sukis	708	127	857	99	209	1,890
Out of Fresno	0	10,221	140,017	0	**14,213**	0

The first two columns in this matrix represent movement within the local Shaw Avenue region. The third column shows movement to the region from other Fresno area stations while the fourth column represents movement to the region from outside the Fresno area. The last two columns represent vehicles that appear for the first time at one the Shaw neighborhood stations. The column labeled initial test shows the number of transactions that had an I in the inspection reason category, signifying an initial test. The inspection reason variable is a little suspect though as there are 14,213 initial transactions conducted at stations outside of Fresno. Transactions that were not conducted at Fresno stations were purged from the data set and thus it appears that these 14,000 transactions have an incorrect inspection reason variable. This is alarming as many BAR statistics are calculated using the inspection reason field, and inaccuracies in this variable will cast doubt on many fundamental statistics. The last column, First Appearance, represents vehicles that have undergone smog check transactions prior to January 2000 which are contained in the data set. These vehicle thus appear in the data for the first time at a Shaw Avenue station but have had previous transactions. Transactions in this column have a 0 in the previous station field and any inspection reason other than I (for initial test).

The numbers in the chart show that most of the transactions in the Shaw Avenue area first appear at these stations but have had previous transaction occur outside the scope of the data set. The Shaw Avenue region also draws more transactions from other Fresno stations than from other shops in the area. Few transactions moved from outside of Fresno to this region. There appear to have been many initial transactions conducted in this neighborhood but these results do not appear to be reliable in any way.

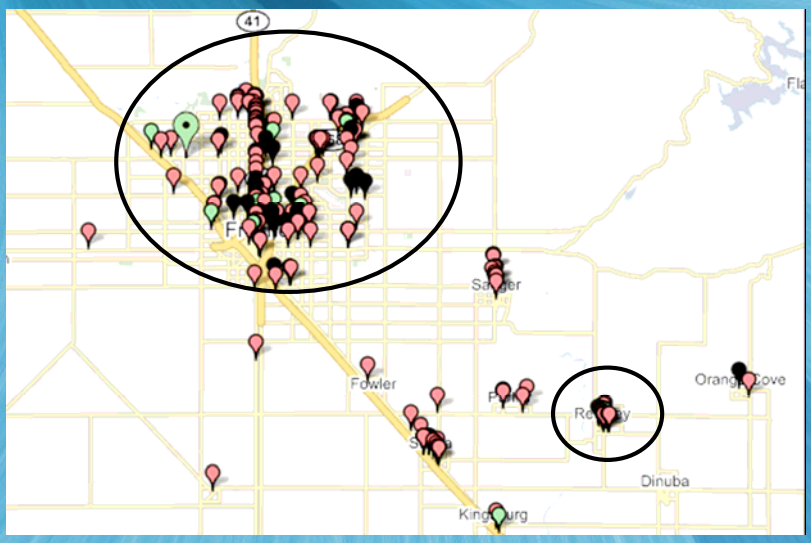


The biggest result is that the matrix outlining movement between stations really gave us little information i.e., there is not much movement between stations in the Shaw Avenue neighborhood. This lack of movement between stations implies that these stations in close proximity really are not strong competitors and that this isolated geographic area cannot be considered a stand alone market for smog checks.



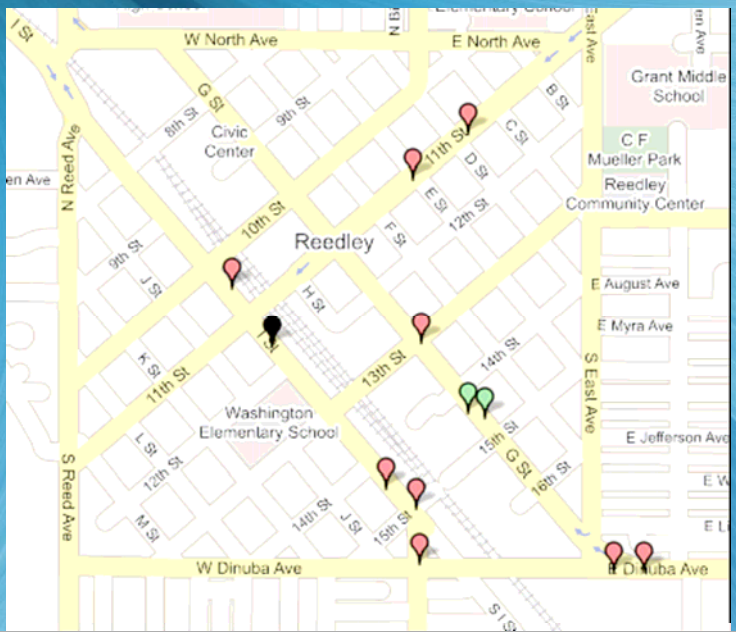
One reason for the lack of a distinct Shaw Avenue market for smog checks may be that the area is not geographically isolated. Looking at the map of Fresno area stations, maybe the Shaw Avenue area is part of a larger, metro Fresno smog check market. Perhaps the results will be different if we look at an area that is more geographically isolated.

Reedley and Fresno Markets?



Maybe Reedley is a better candidate for a distinct geographic smog check market. Reedley is 20 miles from the nearest town and is separated from Fresno by country roads.

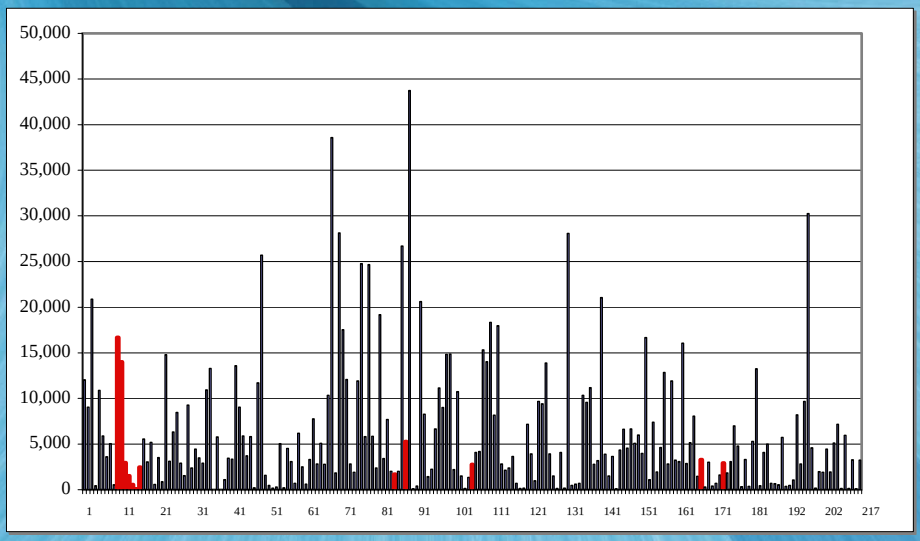
Reedley



Reedley is home to two Gold Shield stations, one Test Only station and nine Test and Repair stations.

There are three new car dealers and 12 stations in very close proximity.

Reedley Station Activity



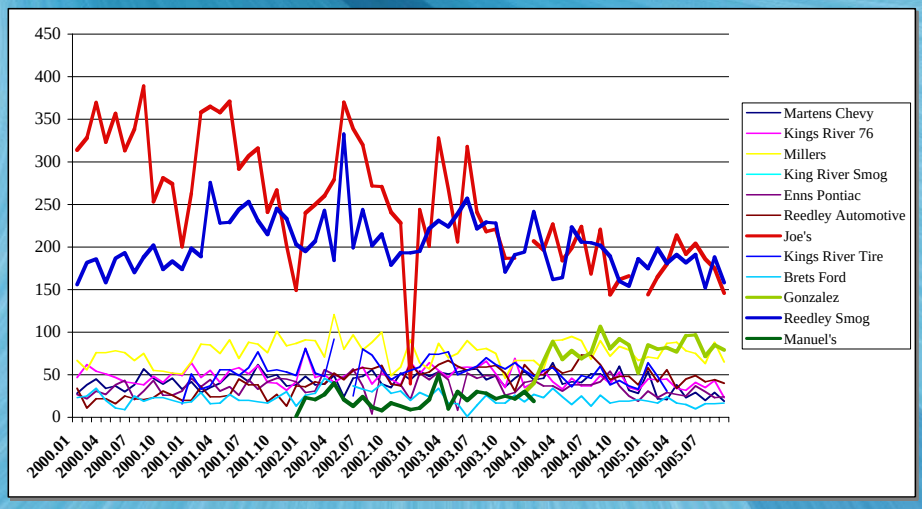
The volumes conducted by Reedley stations are highlighted in red. There are two stations on the far left whose volume dominated the other 10 stations over the time frame of the data set.

Reedley Station Details

Station	Type	No. Events	Price	Extras
Joe's Automotive Repair	Gold Shield	16,662	$60.00	
Reedley Smog & Tire	Test & Repair	13,994	$60.00	Open weekends
Millers Radiator & Muffler	Test & Repair	5,283	$48.25	
Kings River 76	Test & Repair	3,267	$68.25	
Reedley Automotive	Gold Shield	2,936	$73.25	Opens at 8
Martens Chevrolet & Oldsmobile	Test & Repair	2,906	$73.50	
Kings River Tire & Service	Test & Repair	2,762	$50.00	Open weekends
Enns Pontiac Buick & GMC	Test & Repair	2,482	$70.25	Dealer
Gonzalez Automotive Repair	Test & Repair	1,685	$48.20	Open weekends
Brets Ford	Test & Repair	1,507	$86.25	
Manuel's Automotive & Tows	Test & Repair	547	$60.00	Opened August 2003
King River Smog	Test Only	88		Conducted smogs in March & April 20

The two stations conducting the highest volume of customer transactions are Joe's Automotive and Reedley Smog. Looking at the prices of an inspection, it appears that your smog check dollar may go farther in Fresno. Notice that the only Test Only station (King River Smog highlighted in blue) conducted inspections only for a short time at the beginning of the data set. This means that all Reedley directed vehicles must travel outside of the area to obtain a smog check.

Station Transactions per Month

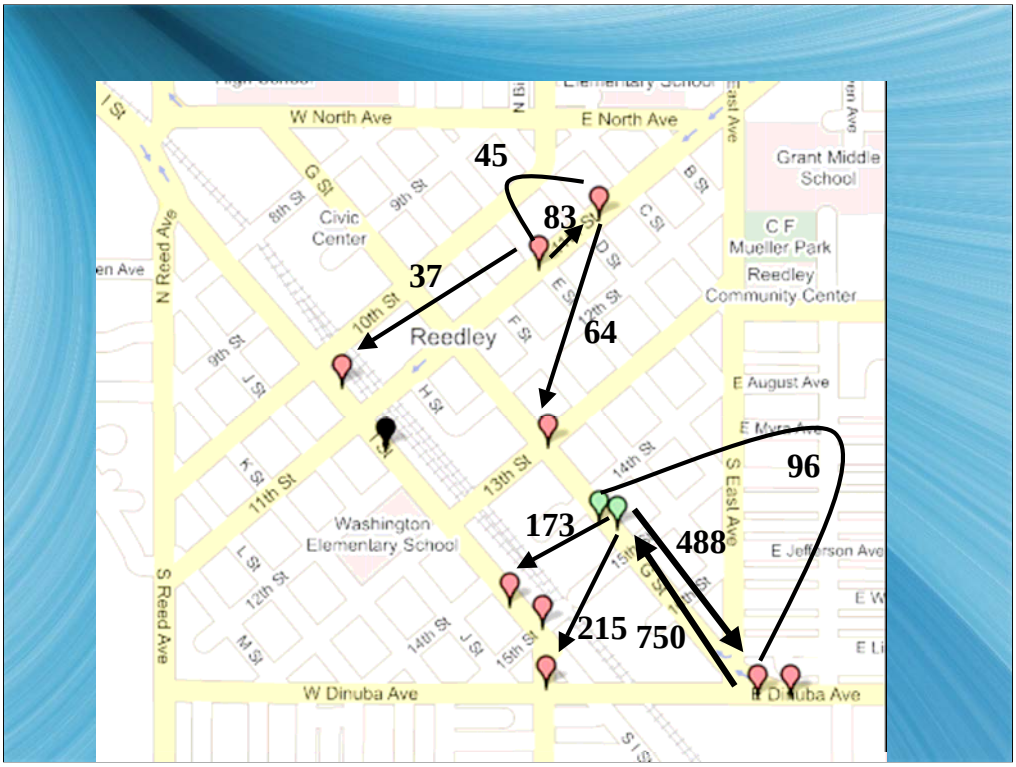


This graph of customer transactions per month is a little overwhelming but it does highlight the dominance of Joe's Automotive and Reedley Smog from 2000 through September 2005. Joe's Automotive shows a downward trend over time while Reedley Smog's monthly volume has stayed fairly consistent.

Movement In Reedley

Current Station \ Previous Station	Martens	Kings River 76	Miller's	King River	Enns	Reedley Auto	Joe's	Kings River Tire	Brets Ford	Gonzalez	Reedley Smog	Manuel's
Martens	**750**	37	29	0	20	23	67	20	10	2	28	1
Kings River 76	39	**1153**	45	0	27	12	79	20	13	0	27	2
Miller's	33	83	**1477**	1	61	37	199	76	20	5	96	5
King River	0	0	3	**3**	0	1	3	12	0	0	5	2
Enns	20	32	64	0	**677**	16	56	23	3	1	23	1
Reedley Auto	33	44	100	0	25	**630**	173	52	15	5	96	5
Joe's	72	75	102	1	59	83	**4426**	114	31	22	**488**	12
Kings River Tire	39	52	85	0	24	43	173	**626**	16	2	113	2
Brets Ford	5	7	18	0	6	9	26	12	**131**	0	9	2
Gonzalez	13	12	26	0	12	19	215	41	6	**141**	167	3
Reedley Smog	25	50	103	0	31	83	**750**	92	28	23	**3051**	6
Manuel's	4	13	23	0	9	15	62	8	2	4	20	**49**

Looking at the matrix of movement between Reedley stations we can see that vehicles tend to patronize the same station (the bold figures along the diagonal) rather than move between local stations (the off diagonals). I did find it interesting that there was not more movement from Kings River (the Test Only station shown in blue) to other local stations. Some interesting movement between Joe's Automotive and Reedley smog is highlighted in red. I find it odd that the number of transactions moving from Joe's to Reedley Smog is 7x larger than the movement from any other local station. Similarly, 488 transactions move from Reedley Smog to Joe's, more than 4x the movement from any other station. To the best of my knowledge these stations are not related in any way.

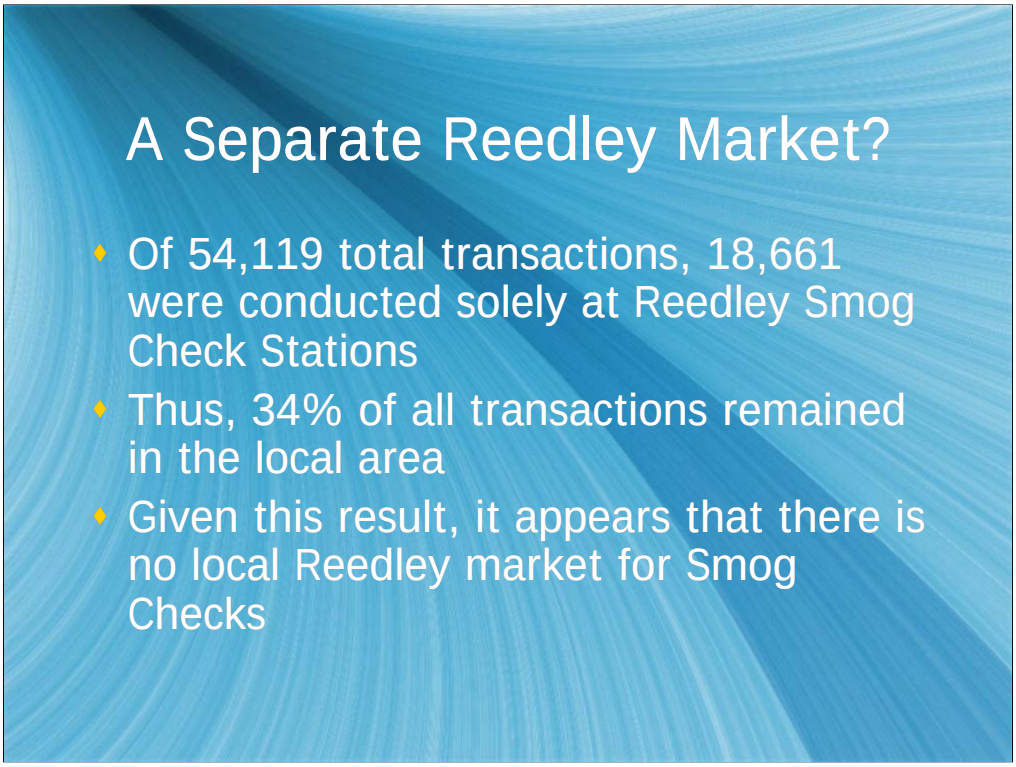


Looking at the movement on the map it is surprising that 750 transactions moved from Reedley Smog to Joe's while only 96 moved to Reedley Automotive, given their close proximity.

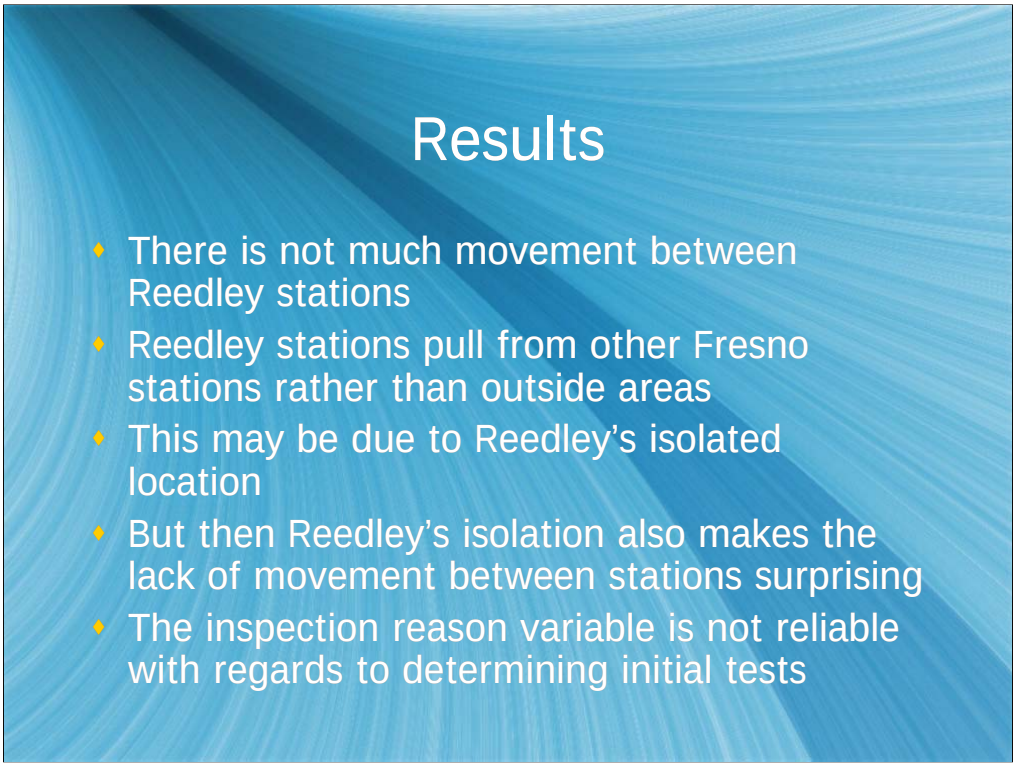
Migration to Reedley

Current Station	Previous Station: Same Station	Local Stations	Fresno Stations	Out of Fresno	Initial Test	Initial and NO Previous	First Appearance
Martens	750	237	276	28	81	59	1,556
Kings River 76	1,153	264	274	32	119	58	1,486
Miller's	1,477	616	583	82	227	144	2,381
King River	3	26	37	2	8	4	16
Enns	677	239	225	17	69	57	1,267
Reedley Auto	630	548	543	0	140	94	1,121
Joe's	4,426	1,059	1,904	282	1,174	898	8,093
Kings River Tire	626	**549**	**385**	56	134	75	1,071
Brets Ford	131	94	160	21	91	76	1,025
Gonzalez	141	514	474	83	142	100	373
Reedley Smog	3,051	**1,191**	**2,211**	363	1,864	1,324	5,854
Manuel's	49	160	144	23	42	23	148

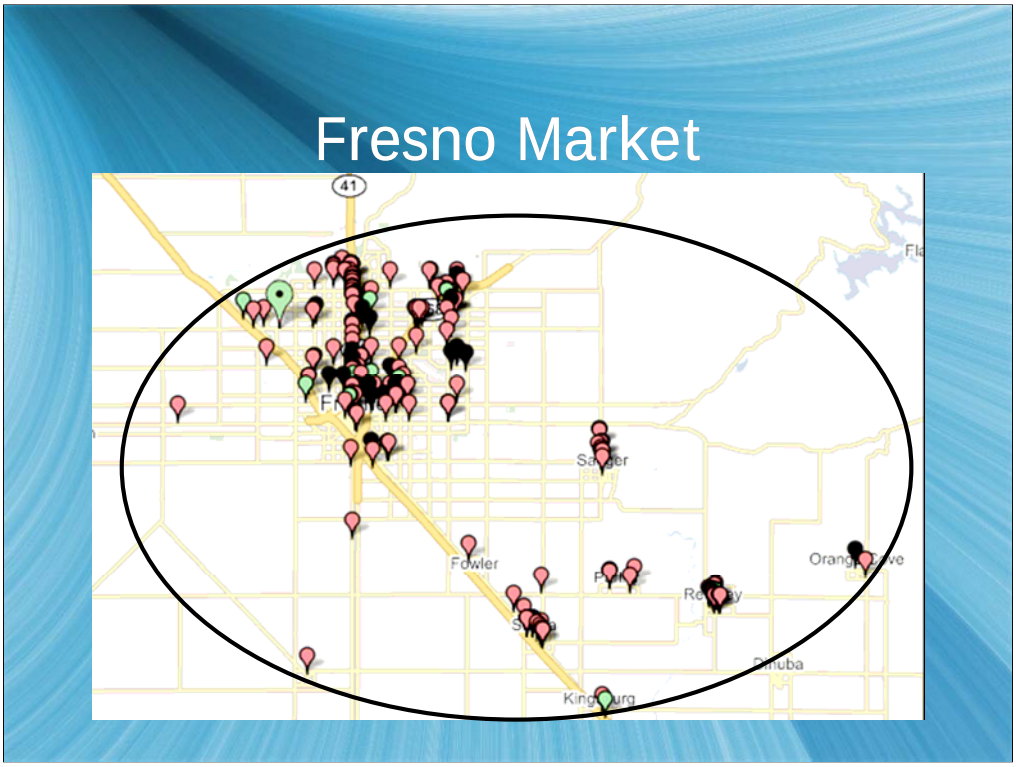
This chart outlines where the transactions conducted in Reedley originate. The first two columns represent transactions that stay in Reedley for two test cycles. Comparing the first two columns with the third column, we can see from the chart that the majority of Reedley transactions come from the Fresno area. Kings River Tire is the sole exception, as it draws more transactions form local stations than other stations in Fresno. This chart again includes a column for initial test which consists of all transactions with an I in the inspection reason field. As I am very suspicious of the accuracy of this variable I created another column containing all transactions with an inspection reason I and a zero in the previous station field. This column labeled 'Initial and NO Previous' should match the Initial Test column, if in fact all transactions with an I in the inspection reason field are initial tests. These two columns are extremely different, which leads me to doubt the accuracy of the inspection reason variable even more.



Though a larger portion of transactions stay in Reedley for two test cycles, as opposed to the Shaw Ave area, there is still not enough retention for it to be considered a distinct geographic market. This means that the stations in Reedley compete with other stations in the Fresno area and not just with stations that are geographically close.

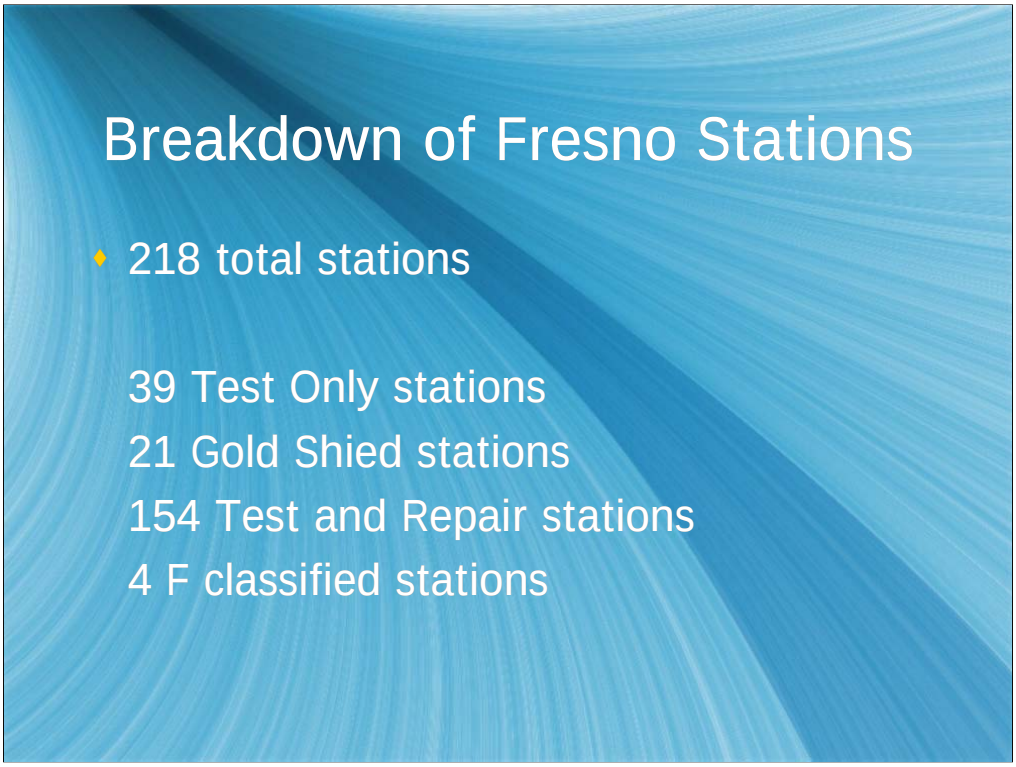


The lack of movement between Reedley stations may also, in part, be due to the lack of a Test Only station in Reedley for a large portion of the dataset. But I do not feel that this alone accounts for the total lack of movement between stations.



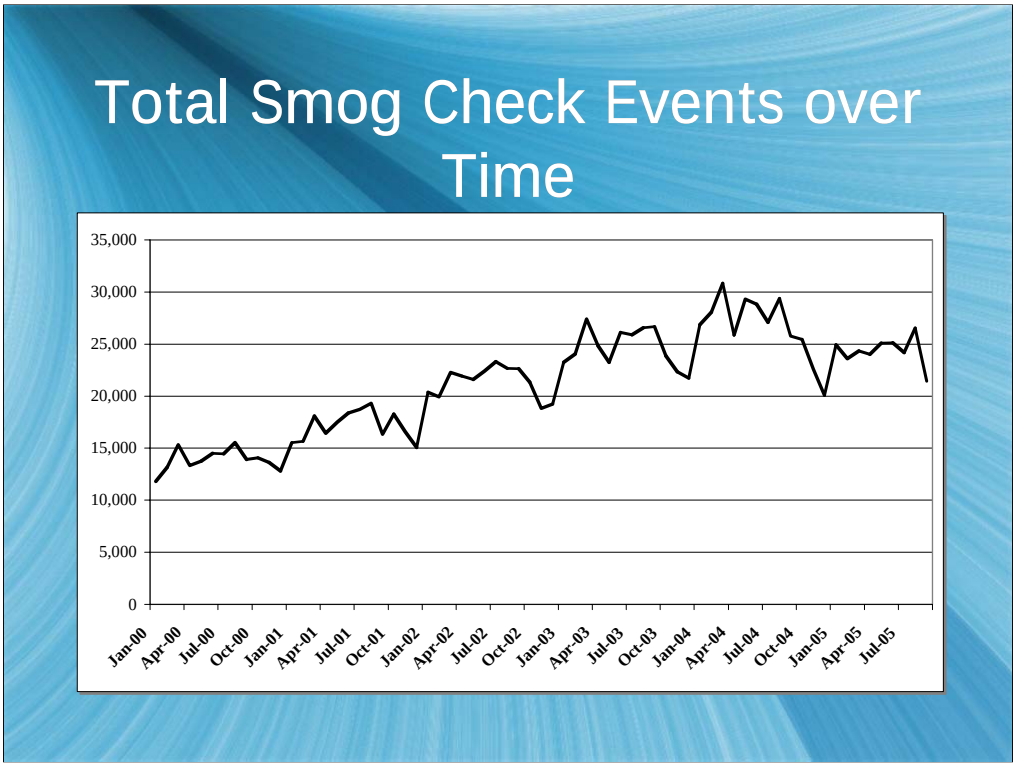
Thus, it appears that there is most likely one large geographic market for smog checks in the Fresno area. Stations then face competition from all 217 other smog check stations in the region, making station comparisons difficult.

Concluding that there is one large geographic market for smog checks in Fresno, it is extremely difficult (and time consuming) to do a pair-wise comparison of all stations. So in order to examine competition between stations, I will aggregate the stations by classification and analyze the competition between different station classifications in the Fresno region.



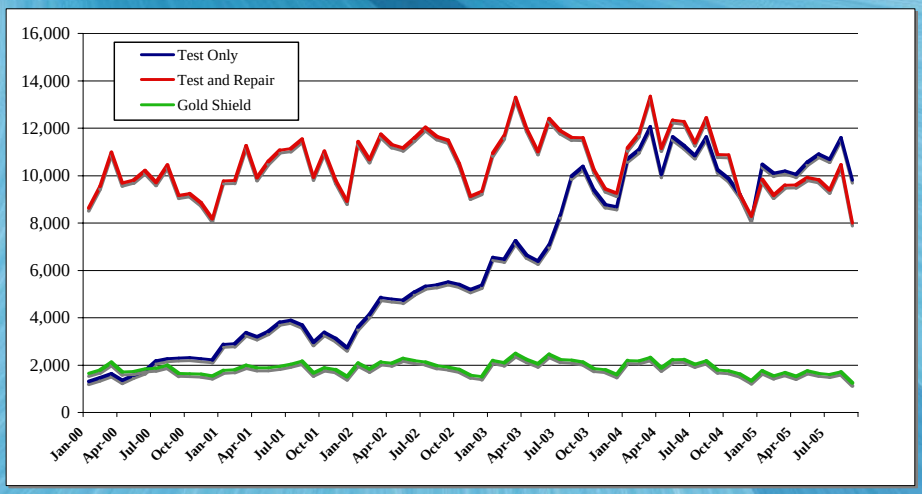
Of the 218 smog check stations under the jurisdiction of the Fresno BAR office, 18% are Test Only stations, 10% are Gold Shield, 71% are Test and Repair stations, and 2% are F stations. F stations are industrial smog check stations, like Version and UPS, that do not conduct smog checks for the public but only on their private fleet of vehicles. Smog checks conducted at F stations are not included in my dataset which effectively reduces the number of stations to 214.

Looking further into the standard station classifications, I identify those stations that are part of a chain. In this context, chain refers to two more more stations under the same ownership. Thus franchises, like The Pep Boys, as well as privately owned shops are included in this classification. There are 49 stations in the Fresno area that are part of a chain; 2 Gold Shield stations, 15 Test Only stations, and 32 Test and Repair stations. 23 Test and Repair stations are also classified as new car dealers.



The total number of smog check transactions increased over the time period January 2000 through September 2005.

Transactions by Station Type



Looking at monthly volume by station type, we see that as of January 2004, Test Only stations conducted a higher volume of transactions than Test and Repair stations. The volume conducted at Gold Shield stations meanwhile, has stayed relatively consistent over time.

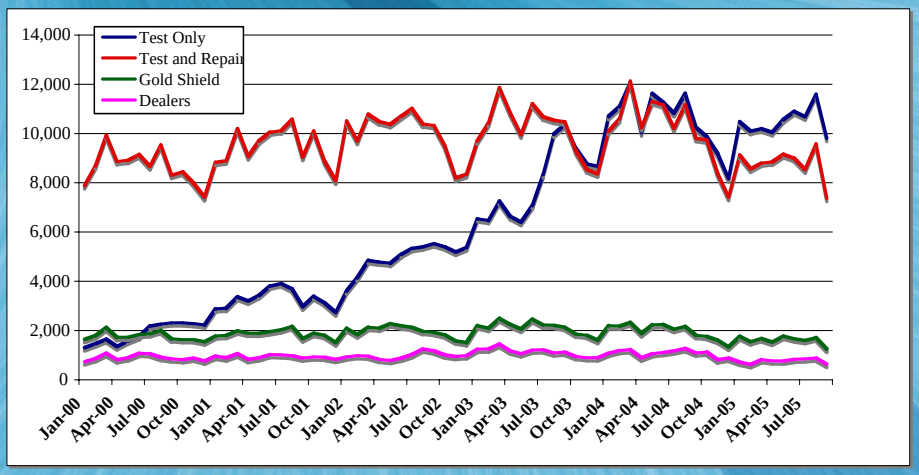
Pass Rate* by Station Type

Station Type	# Events	Pass Rate
Test & Repair	727,393	84.86%
Test Only	438,399	79.43%
Gold Shield	130,734	80.07%

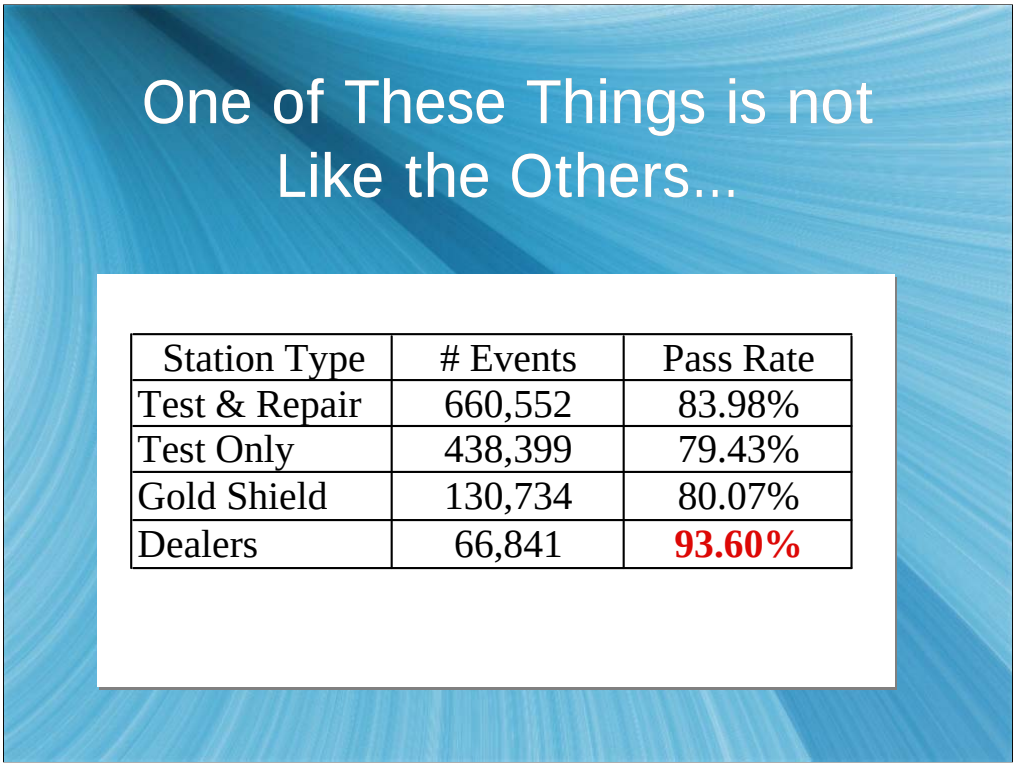
I then calculated pass rates for each stations classification. These results come with a very large caveat. These are the pass rates for all customer transactions in the Fresno region, not for all inspections or even initial inspections. Thus these pass rates cannot be compared to any published BAR pass rates. Nevertheless, these pass rates present some interesting results. The pass rates for Test Only and Gold Shield Stations are very similar while the Test and Repair pass rate is significantly higher.

These three station classifications are the basis for much of the analysis conducted on the smog check program and subsequent policy recommendations. Grouping stations into these categories requires the assumption that all stations within each category are homogenous. But does this assumption hold? Is there a better way to classify and analyze smog check stations?

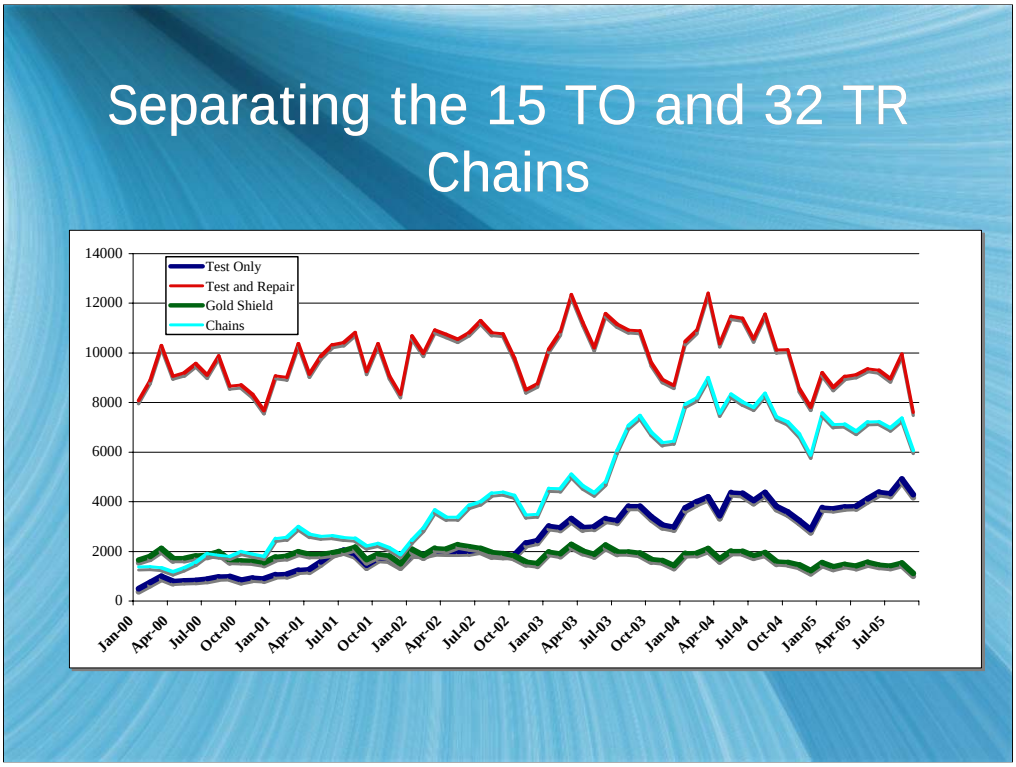
More Station Classifications



This graph introduces a new station category, new car dealers. There are 23 new car dealers in the Fresno area that conduct smog checks. All of these dealers are Test and Repair stations. Thus in this graph the Test and Repair category (graphed in blue) now excludes these 23 new car dealers which have been moved to their own category. As we can see, dealers (shown in pink) do not perform a large volume of smog checks, but their volume is comparable to that of Gold Shield stations.



Dealers may not conduct a significant volume of transactions, but the pass rate of new car Dealers is significantly different from all other categories! The pass rate of Dealers is wildly different from that of other Test and Repair stations. Thus, it is not clear to me that Dealers have much in common with other Test and Repair stations and calls into question the traditional categorization of stations in which the two are lumped together.

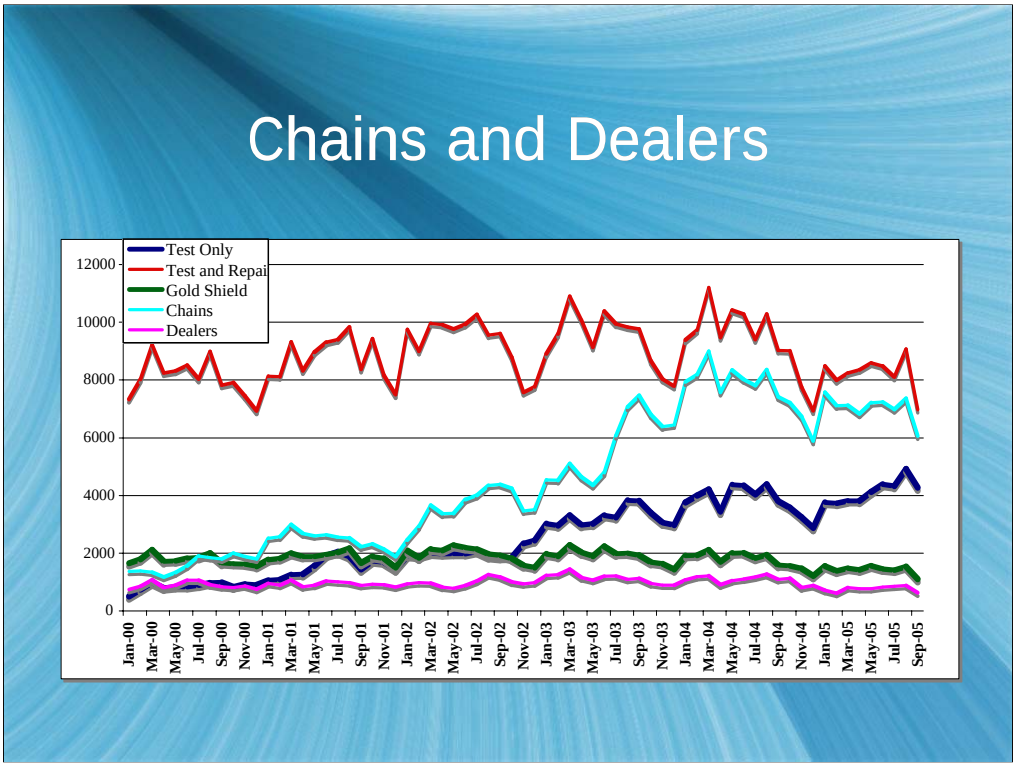


In this graph I introduce a separate stations classification, Chains. All the Chain stations have been stripped from their original classification, thus the Test Only category no longer contain s the 15 Chain stations, the Test and Repair category no longer contains the 32 Chain stations, etc. The graph of the number of transactions conducted at Chain stations (the aqua line) shows a remarkable growth in the volume of transactions over the time period. In fact, Chains conduct a higher volume of transactions than Test Only stations. This result really surprised me.

Pass Rates*

Station Type	# Events	Pass Rate
Test & Repair	680,510	85.21%
Test Only	174,969	82.06%
Gold Shield	124,245	79.78%
Chains	316,802	78.18%

Looking a the pass rates of these classifications, Chain stations have the lowest pass rate of all station types. This result follows the findings of Thomas Hubbard who found no reputation effect at smog check stations that are part of a chain. The removal of Chain stations from the Test Only category increases the Test Only pass rate so it more closely resembles that of Test and Repair stations, while the pass rate of Gold Shield stations is more similar to that of Chain stations.



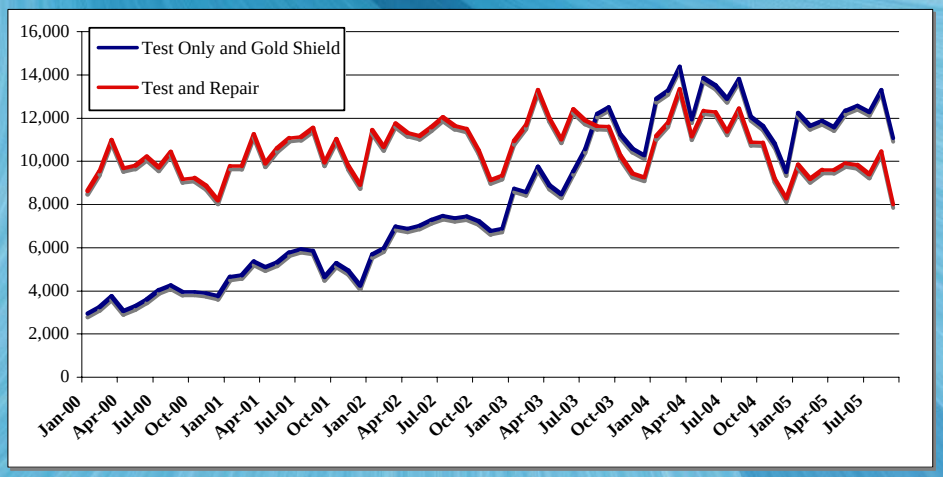
We noted before that the volume of transactions conducted by Dealers is very similar to that of Gold Shield stations. So why are Dealers not considered an individual category? This graph asks, what does the volume of transactions look like if there are 5 station classifications? The blue Test and Repair category now has been stripped of all Chains and Dealers, reducing the number of stations in this category to 99.

Detailed Pass* Rates

Station Type	# Events	Pass Rate
Test & Repair	613,669	84.29%
Test Only	174,969	82.06%
Gold Shield	124,245	79.78%
Chains	316,802	78.18%
Dealers	66,841	93.60%

When there were only 3 station classifications, Test Only and Gold Shield had similar pass rates (79.43% vs. 80.07% respectively) but now Gold Shield and Chains are more similar. Given 5 classifications, the Test Only pass rate more resembles the pass rate of Test and Repair stations. It is not transparent to me that 3 stations classifications is any more accurate than 5. Nor it is clear why the 3 classic classifications, Gold Shield, Test Only, and Test and Repair are chosen as a way to compare station performance.

Two Classifications



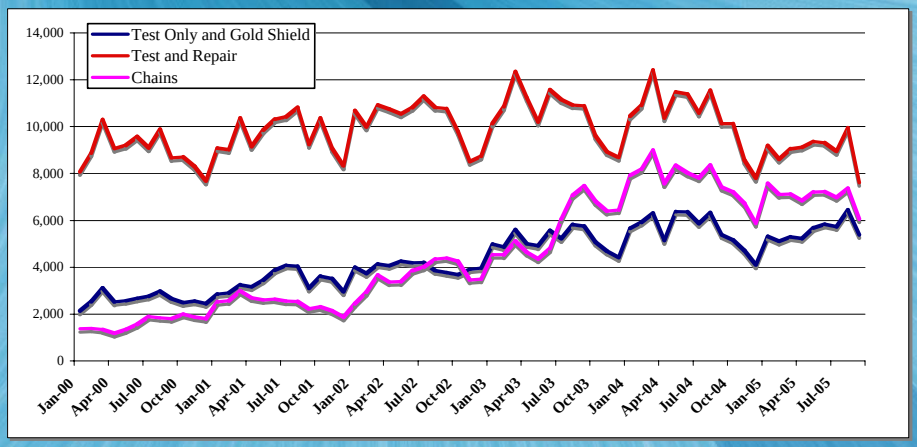
Why 3 classifications, why not 2? This graph combines the Test Only and Gold Shield stations into one category. The volume of transactions conducted by the new TO/GS classification overtakes Test and Repair stations in August 2003 (as opposed to TO overtaking TR in January 2004 given 3 categories).

Pass* Rate Comparison

Original		
Station Type	# Events	Pass Rate
Test & Repair	727,393	84.86%
Test Only	438,399	79.43%
Gold Shield	130,734	80.07%
Hybrid		
Station Type	# Events	Pass Rate
Test & Repair	727,393	84.86%
Test Only & Gold Shield	572,643	79.56%

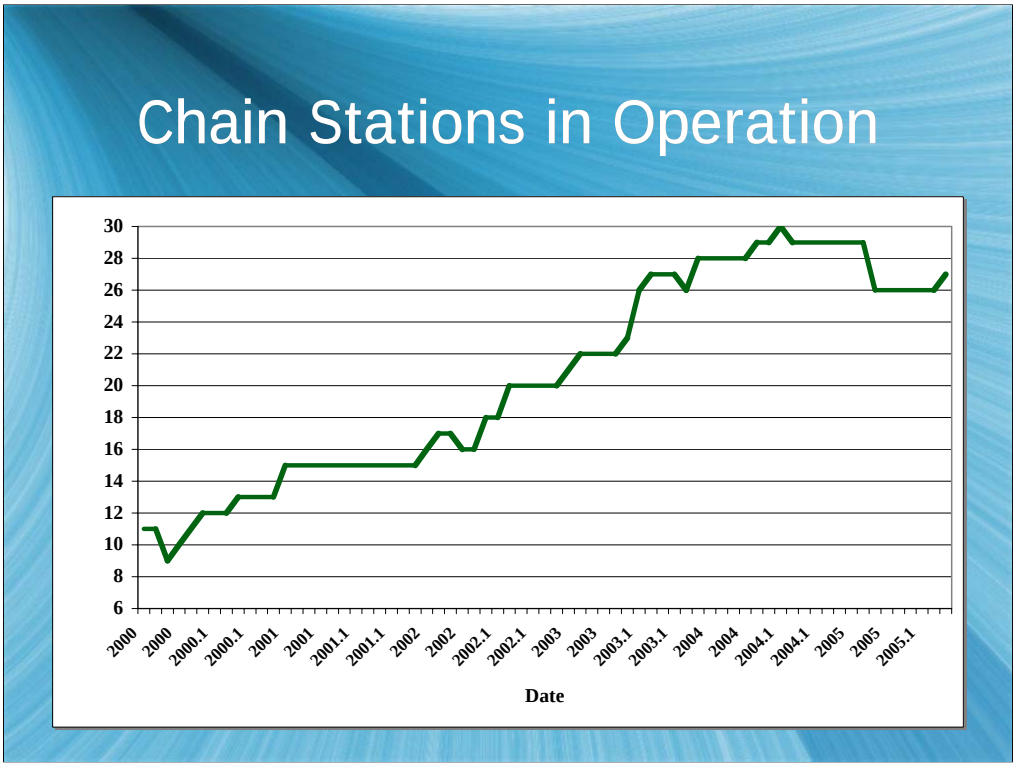
In the hybrid, 2 category, scenario the number of transactions (here labeled events) conducted by each station category is more similar than in the original, 3 category, scenario. But there is not much difference in the pass rates of the two scenarios. It is not obvious to me that one scenario is preferable to the other.

Three New Categories



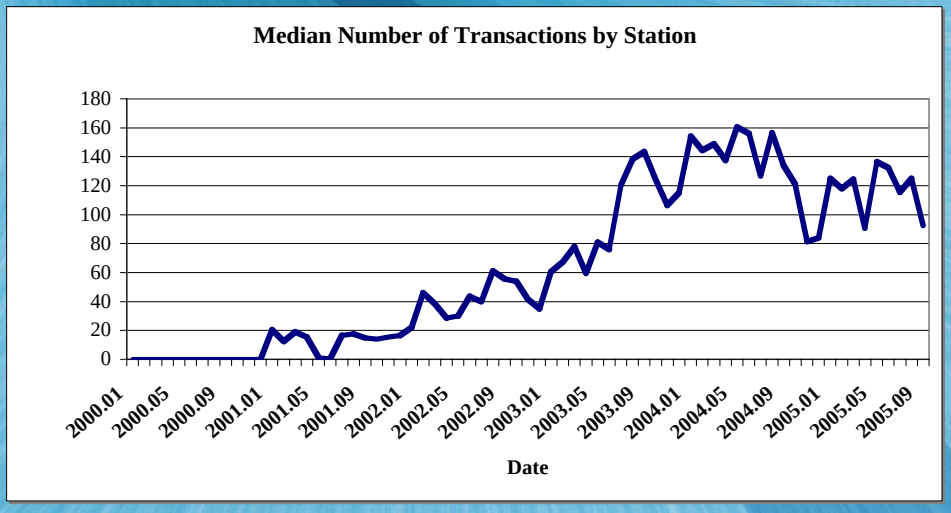
What if we divide the Fresno area stations into 3 new categories? Given the dominating growth of transactions conducted at Chain stations, it seems logical that Chain is an importation category that should be included. In this new classification, the volume of transactions at Test and Repair stations dominates all other categories (including the combination TO/GS category). While you may question the relevance of rearranging station classification, it is importation to note that the classification of stations does have a large impact on policy decisions. Station classification and the comparison of pass rates affects the percentage of vehicles directed to Test Only stations, a highly controversial policy. Station classification also affects the emission credit California receives from the EPA as a result of the smog check program. Thus, it is important that stations classifications and the assumptions that underlie these categories are investigated.

Regardless of how we classify the stations, it is evident that Chain stations have had a surprising growth in their volume of transactions.

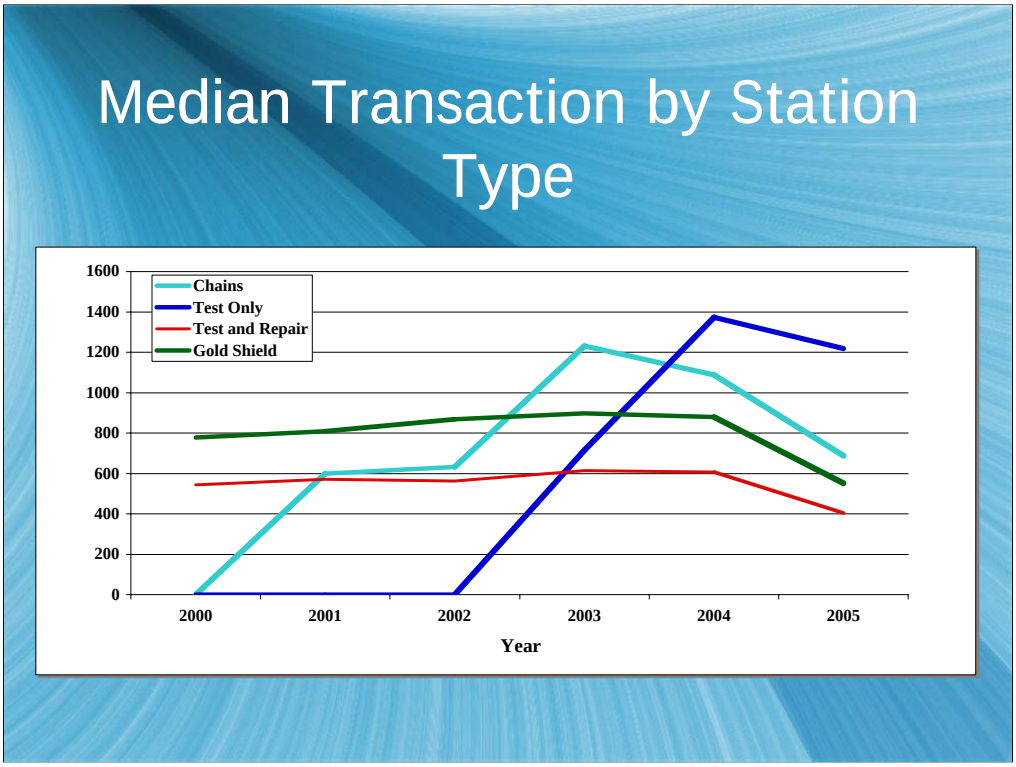


But has the number of Chains increased or has the volume of transactions per Chain station increased over time? From this graph it is clear that the number of Chain stations in Fresno has increased greatly over time, from a low of 9 to a high of 30.

Median Transaction per Chain

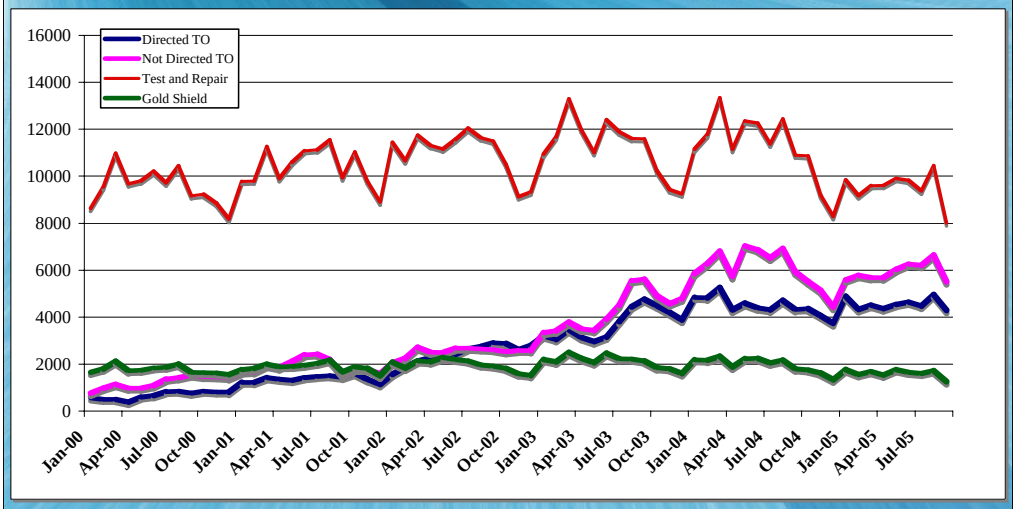


The median volume per Chain also increased over the dataset. Thus it appears that both the number of Chains and the volume per Chain has increased over time. How has this affected the other types of stations?

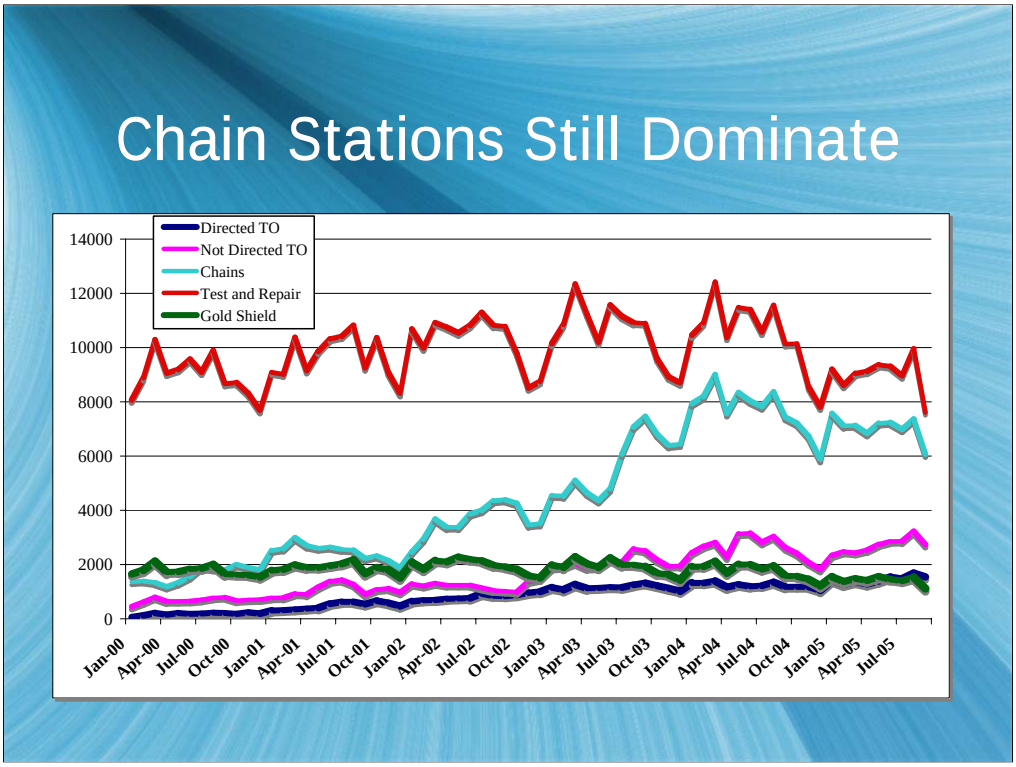


As the graph shows, the median number of transactions for each station type has decreased since 2004. The trajectory of Test and Repair stations is very similar to that of Gold Shield stations, while the paths of Test Only stations and Chains resemble one another. Both Chains and Test Only stations experienced periods of rapid growth not seen in the other station categories. From this graph it does not appear that the rise in median transactions for Chain stations has adversely affected the growth of Test Only stations. The increased number of transactions per Chain may have stunted the growth of Test and Repair and Gold Shield stations, but this graph does not present enough information to make that conclusion.

What About Directed Vehicles?



What if we look at station classification from a new angle and divide the transactions conducted at Test Only stations into those that were directed and those that were volunteers. As we can see, the volume of Test Only volunteers has grown substantially over the dataset. As of January 2003, the volume of transactions conducted in which the vehicles were volunteers to Test Only stations surpassed the volume of directed vehicles. This is definitely a trend worthy of further analysis.



When we separate out the Chain stations, the volume of transactions in which the vehicle is a Test Only volunteer surpasses the directed vehicles over the nearly 6 years of data. The Chain stations continue to dominate all categories with the exception of Test and Repair stations.

Ideas for Future Research

Tests Conducted at TO Stations			
		# Events	Pass Rate
	Directed TO (HEP)	192,917	73.70%
	Not Directed TO	245,482	83.94%
	S Random Directed TO	12,269	79.26%
	All TO except S Directed	426,130	79.44%
Tests Conducted at All Stations			
	Directed TO (HEP)	224,737	73.18%
	S Random Sample	14,429	78.73%

In the vein of directed vehicles and volunteers, in the future I would like to investigate the pass rates of these different groups of vehicles. The very preliminary results shown above really indicate that further research is warranted and that some interesting results may be found.

Conclusion

- Further research into station classification is warranted especially in regards to chain stations
- Competition is not strong between geographically close stations, thus the extent of the Fresno smog check market is quite large and can not be divided into smaller neighborhood markets
- While the price of inspection and hours of operation may guide consumers' choice of station, little correlation was found between those variables and the number of transactions per station